Paving and Municipal Engineering

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THE VARIOUS CEMENTS AND HOW TO USE THEM.

THAT the use of cement in this country in building operations of the architect, and the larger and heavier constructions of the engineer, is rapidly increasing as its value becomes known, is apparent to all engaged in works of construction, and is evidenced by the amount of increase in importations of foreign cements, as in the year 1876 only 50,000 barrels were imported, as against 3,000,000 barrels in 1893, while the use of cements manufactured in this country has kept pace with the importation, 8,000,000 barrels having been used in 1893.

Cement is used very largely in the preparation of foundations for all important buildings, foundations for bridge masonry, flooring of buildings, as stucco for outside walls, lining of tunnels and arches, or of piers and abutments on railroads where the masonry has become cracked and unsafe; sidewalks, curbing and even buildings are now constructed with it. With all its various uses the users are often ignorant of its properties, its proper treatment and what they have attained after using, and to give in as few words as possible the result of many experiments and tests from many sources is the object of this article.

Cements are divided into, generally, two classes—the natural or Rosendale and the artificial or Portland. The natural being simply a hydraulic stone calcined and ground, and to this class belong the Anchor, Commercial Rosendale, Improved Rosendale, Utica, Louisville, Milwaukee, Akron, Hoove's Cave, Round Top and many others. The Portland cement, so called from its resemblance to Portland stone when set, was originally made in England, but its manufacture has extended to many countries, our own included,

and is known commercially frequently by the name of the manufacturer, while the natural is generally named from the locality where found. Germany now probably leads in the manufacture of Portland cement, and Alsen, Dyckerhoff, Shifferndecker, Hemmoor, Stettin, Germania, are familiar names to the cement user.

In making a mortar for use in any construction, to obtain the strongest work it is absolutely necessary that all voids in the sand shall be filled, and in a mixture for concrete the same rule applies. In a concrete the voids in stone or gravel should be filled with sand, the voids in the sand by the cement paste, and the finding of these voids is a very easy matter should one care to go to the trouble, and not rely on published experiments, and for important work the architect or engineer will feel that he has neglected nothing to secure the best results if he makes his own experiments. A method of ascertaining the voids will be found in "Trautwine," as well as the following table of voids in sand. P. 677, edition 1892:

Weight of Cubic Foot of Sand, dry, lbs.	80	85	90	95	100	105	110	115
Proportion of Solid	.485	.515	.546	.576	.606	.636	.667	.697
Proportion of Voids	.515	.485	.454	.424	.394	.364	.333	.303

From the above table the cement user can ascertain very closely the voids in any sand by simply drying and ascertaining the weight of a cubic foot, and that it may pay him to do so is evident on noticing that the voids vary 20 per cent. between sand at 80 pounds and sand at 115 pounds per cubic foot. It can generally be assumed that the voids will be from 33 to 40 per cent. in ordinary river or pit sand. The finer the sand the greater the voids, generally. Cement, sand, gravel and stone all shrink in volume on shaking, from their volume as *loose* materials. Mr. Thos. H. Johnson, in 1878, established the proportions of materials entering into concrete for the Indiana State Capitol after a series of carefully conducted experiments, which were published by the State House Commissioners in their report for that year. He gives the following table as "Showing the best proportions of materials for concrete on well shaken materials:"

	No. of Experiments.						
Materials.	1	2	4	5	6	7	8
Broken Stone	10	.....	5	.....	5	3	3
Gravel	.....	10	3	.....	3	3	3
Sand	6	4½	3¾	4	3	3	2¾
Dry Cement	4½	2½	3¼	2¾	4	3½	2¼
Water	1¾	1¼	1	1	1½	1¼	1

Experiments Nos. 6, 7, 8 he does not regard as entirely reliable, but approximately so.

He also gives the following table as "Showing the least proportions that will give a perfect bond:"

Materials.	No. of Experiments.				
	1	2	4	5	8
Broken Stone	4	.....	5	.....	3
Gravel	.....	5	3	.....	3
Sand	2	1¾	3	2	2¼
Dry Cement	1	⅞	1½	1	1⅛
Water	⅓	⅔	1½	⅞	½

His experiments were conducted with Louisville cement entirely, and he found that to make one measure (or unit) of mortar would require 1.33 measures of dry cement powder and .51 measures of water. The cement shrinking in this case 25 per cent. The percentage of voids in the materials used he found to be: Broken stone, 51.50; gravel, 37.75; sand (earth damp), 39.75; sand (wet), 32.87.

The wet sand shrank in volume on addition of water 9.37 per cent., and the earth damp sand shrank only 7 per cent.

A concrete made by Mr. D. Fitzgerald and used in lining a water works tunnel at Boston (Trans. A. S. C. E., March, 1894) was composed of "one cask of cement, as it came from the dealer, two and one-sixth casks of loose sand, and five and one-half casks of loose crushed stone." By slightly shaking the sand and stone in the casks it was found that this amounted to practically the proportions 1, 2 and 5. By actual measure this was found to make 20 cubic feet of concrete when thoroughly rammed. The cask of cement he found to contain 3.425 cubic feet, so that the loose aggregates contain 26.258 cubic feet before mixing and 20 cubic feet in place, a loss in aggregate of loose material of 24 per cent. and of shaken material of 16.5 per cent.

Mr. Ransome has prepared a table showing the cement required for 100 cubic feet of concrete and loss in percentage of aggregates which is useful as giving a close approximation. The table is appended:

Proportion of cement to aggregates.	Bbls. cement by bbls. as received from manufacturers.	Bbls. cement when proportioned by measurement.	Cubic yards of aggregate.	Cubic feet of aggregate.	Percentage of loss on aggregate.
1 to 1	18.3	15.8	2.75	74.25	.....
1 " 2	16.6	10.	3.85	103.95	3.80
1 " 3	8.7	7.5	3.95	106.66	6.25
1 " 4	6.9	5.9	4.15	112.05	10.70
1 " 5	5.6	4.7	4.80	116.09	13.86
1 " 6	5.0	4.3	4.40	118.78	14.93
1 " 7	4.4	3.7	4.45	120.15	16.77
1 " 8	3.9	3.3	4.46	120.41	16.97
1 " 9	3.4	2.8	4.47	120.68	17.15
1 " 10	3.0	2.6	4.48	120.95	17.34
1 " 11	2.8	2.4	4.50	121.49	17.69
1 " 12	2.5	2.2	4.53	122.31	18.24
1 " 13	2.4	2.0	4.55	122.85	18.60
1 " 14	2.3	1.9	4.57	123.40	18.98
1 " 15	2.2	1.8	4.59	128.95	19.36
1 " 16	2.1	1.7	4.62	124.75	19.84
1 " 17	2.0	1.6	4.63	125.00	20.00
1 " 18	1.9	1.5	4.65	125.56	20.36
1 " 19	1.8	1.4	4.68	126.30	20.82
1 " 20	1.7	1.3	4.70	126.90	21.95

From the above table a close approximation of all material entering into concrete can be made, but a safer one could be made by experimenting on the materials that it is the intention to use in any work, and in important undertakings the intending contractor should make them for himself under all the conditions that will be imposed upon him by the specifications.

More tests have been made on neat cement in this country than on any other, while Germany, France and other countries have made their tests and established their standards on a mixture of sand and cement, generally in proportion of one of cement to three of sand; this is no doubt more satisfactory to the cement user, but the varying quality of sand will render one set of experiments incomparable with another set made with a different quality of sand; the amount of water used in mixing, the care of the operator in filling moulds, the operator's "personal equation," and the failure of briquettes to break exactly as others made from the same batch all conspire to render a comparison of tests made by different persons of doubtful value, so the only safe plan is for the user to depend upon his own tests and make his comparisons from them. That it is safe to follow this rule is seen on examination of the circulars and advertising matter issued by the different manufacturers. In these

are often given tests made by good experimenters and careful engineers, but it will be noticed that the cement being advertised is always much better than its rivals.

In making tests of cements for the purpose of knowing its value as it exists in your work, use the cement as it comes from the manufacturer; use the same mixture and the same sand.

In making tests for comparison before purchase, test each cement as you would in the work under your specifications and adopt the best for your work, or test each under the rules adopted by committee on tests of the American Society of Engineers. These rules will be furnished by any manufacturer, and it is unnecessary to repeat them here.

From experiments of Mr. Clark and others the following has been ascertained—that the relation of weight of cement to its strength is an uncertain one:

That the rapidity with which a cement sets gives no indication of its ultimate strength; generally, the slowest setting cement attains the greatest strength.

That the strength, and therefore its value, depends greatly upon the fineness to which it is ground.

That the finer cement is ground the more sand it will carry.

That water used in mixing carrying a small per cent. of clay, works little, if any, harm, and that "clean, pure" water as required in many specifications is not a necessity.

That Portland cement mortars expand (but slightly) in setting, average 1 part in 1,000.

That contact with wood does not tend to disintegrate mortar.

"That cements offer greatest resistance to abrasion when combined with the greatest amount of sand which they can just bind so firmly that it will grind off and not pull out."

That in testing, briquettes one inch square give about same results as briquettes from larger moulds.

That specifying weight per bushel or cubic foot means nothing unaccompanied with further requirements.

That heating materials entering into a mixture lessens the strength.

That the addition of lime is made at the expense of tensile strength.

That "second setting" must not be allowed under any circumstances.

That the use of too much water weakens the construction. Best proportions: Portland, 20 to 25 per cent.; Rosendale, 30 to 35 per cent.

That freezing of Portland cement mortar before setting retards, but does not prevent final setting.

That tensile strength is reduced greatly by use of larger quantities of sand, as shown by Trautwine:

Sand	0	½	1	1½	2	3	4	5	6	7	8
Strength	1	⅔	½	.4	⅓	.3	¼	1-5	1-6	1-7	⅛

Portland cement is imported in barrels weighing about 400 pounds, gross, 380 to 385 pounds net cement.

In natural cements, 265 pounds to barrel, net.

Portland cement weighs from 80 to 100 pounds per cubic foot. Natural cements weigh about 50 pounds per cubic foot. A barrel of natural cement would then contain 5.3 cubic feet, and a barrel of Portland cement would then contain 4.3 cubic feet (average at 90 pounds), if taken by average weight.

A Portland cement barrel measures inside, at head, 15½ inches; at center, 18½ inches, and 25 inches length.

Hutton's rule for finding contents of barrels: Capacity in Imperial gallons $=\left(\frac{\text{1 gallon equals}}{\text{.16046 cubic foot}}\right)=.00003147\ (39\overline{M}^2+25\overline{D}^2+26MD)\ l.$ l=length, D=diameter at end, M=diameter at middle, all in inches. The barrel above given would contain by this rule 3.461 cubic feet. The barrel gauged by Mr. Fitzgerald with water contained 3.425 cubic feet, a difference of only 64 cubic inches between actual measure and the contents by rule, and probably measurements on barrels by different manufacturers.

A cubic foot of concrete averages about 150 pounds in weight.
A " " " gravel " " 115 " " "
A " " " sand " " 95 " " "

Mr. Fitzgerald gives as the result of breaking nearly 25,000 briquettes and experiments extending over seven years, the following table of average tensile strength per square inch:

Portland.	Lbs.	Rosendale. Lbs.	
Neat cement.	102	71	1 day.
" "	303	92	1 week.
" "	412	145	1 month.
" "	468	282	6 months.
" "	494	290	12 "
	160	56	1 week.
	225	116	1 month.
1 sand.	347	190	6 months.
1 cement.	387	256	12 "
		41	1 week.
1½ sand.		95	1 month.
1 cement.		155	6 months.
		230	12 "
	126	24	1 week.
2 sand.	163	60	1 month.
1 cement.	279	125	6 months.
	323	180	12 "
	95	14	1 week.
3 sand.	140	35	1 month.
1 cement.	193	80	6 months.
	257	121	12 "
	55	5	1 week.
5 sand.	88	16	1 month.
1 cement.	136	46	6 months.
	155	80	12 "

The following table prepared from experiments in circulars advertising different Portland cements is given below:

	Cement, neat.				Cement 1; sand 3.			
	7 days.	28 days.	3 mos.	1 year.	7 days.	28 days.	3 mos.	1 year.
Portland No. 1.....	756	982	1021	1045	247	290	341	391
" " 2.....	500	628			158	199		
" " 3.....	767	895			243	312		
" " 4.....	464	615	725	799	176	297	330	
" " 5.....	500	820			200	585		
" " 6.....	795	843			306	367		
Mean.....	630	797	863	922	221	340	335	391
From table above...	303	412		494	95	140		257

The above would indicate either that cements have increased in tensile strength nearly 100 per cent. in the last ten years, or that strength given in last table was obtained under extraordinary conditions. It is to be hoped the former is the case. Experiments on crushing strength of concrete in different proportions are very few in number and greatly to be desired. The crushing strength of Portland cement concrete, sand 2, stone 5, cement 1, the usual proportions may be safely taken at 1,500 pounds per square inch, or 100 tons per square foot. As it is very seldom that pressure on

foundations are allowed to exceed four tons per square foot (depending on nature of the foundation), it will be seen that concrete is an excellent material for compression strain.

Concrete combined with iron or steel beams has been used in Europe for the construction of arches with small rise very successfully, and numerous and costly experiments have been made with a view of using this construction instead of small span highway bridges, and from the reports of the engineers making such tests they were much stronger than the iron bridge, and cheaper. Spans up to 150 feet have been built.

The foundation for bridge at Niagara Falls was made by using beton; over 1,000 cubic yards being required. The bridge now being built at New Orleans over the Mississippi river, having piers 90 feet high, is a shell of stone work, the interior being filled with concrete. It is proposed to build piers and abutments of concrete, casing the outside and top with beton, and where desirable create voids in the concrete by using cement barrels so placed that none are nearer than six inches, thus insuring small columns of concrete with sides of cylindrical shape, such columns resisting well the pressure. The barrels should be filled with sand if foundation will permit. This construction would answer admirably for many bridges, as it can be made much cheaper than good masonry and is far superior to poor. For foundations on poor material the hollow construction would relieve the pressure to a very great extent. An ordinary pier 18 feet high could thus be relieved of 150,000 pounds, about one-fourth ton per square foot, or one-third of total, an item worth saving in many cases. *M. M. Defrees.*

MR. DEFREES, who, until recently, was a member of the board of public works of Indianapolis, and is a successful civil engineer, has had varied and valuable experience in the use of cements and is exceptionally qualified to discuss this subject.

THE PHYSICAL PROPERTIES OF ASPHALT.

ANOTHER REPLY TO CAPT. TORREY BY PROF. DE SMEDT.

IN regard to solubility in alcohol of Trinidad and Bermudez asphalt, I think I have given ample explanation in my little article in this magazine for June.

Captain Torrey's proposition of fractionating by solutions might, on some occasions, be useful, but the last word in regard to investigation of asphalt has not been said yet by chemists, viz: Would it not be interesting and very important to classify asphalts by finding quantitatively the saturated and non-saturated hydro-carbons in different asphalts? This might explain certain changes which some asphalts undergo.

Many other points might be investigated by chemists, but this is not interesting to our readers until more can be said about it; therefore, I shall stop here without discussing Captain Torrey's idea: "When chemists can formulate the structure of an asphalt molecule, etc." This being ridiculous to discuss, it would be waste of time.

Captain Torrey's quotation: "As to the effect of more than 20 per cent. of asphaltine," etc., etc. In order to satisfy the captain I am willing to say that the quality of an asphalt for paving purposes is reduced in the ratio of the percentage it yields of asphaltine.

Captain Torrey says further: "And the writer found by analysis as much as 40 per cent. of asphaltine in an asphalt used in one of the most durable pavements ever laid in this country."

The Captain does not state if 40 per cent. was found in refined or in pure asphalt, or with what this asphalt was softened to make the asphaltic cement; nor does he say where this pavement can be seen. He would call this misleading; he seems to think that skill in laying pavement is of the greatest importance. The good quality of the matrix has its importance, without which no good pavement can be manufactured, and so has the working, the formula and the laying of the pavement. These should all be combined in order to obtain good results.

Quotation from Captain Torrey's comments: "Prof. De Smedt says: "It has been often proved that an asphalt yielding an excess of asphaltine is not fit for pavements, and that an asphalt having lost its petroline by evaporation or otherwise, its good quality can not be restored by the admixture of heavy petroleum oil." Captain Torrey adds: "Suppose one adds maltha to it, what then?"

It seems strange to ask me such a question, when it is not under discussion. I will state though, that such asphalt, provided

the maltha is of a good quality, will be improved in the ratio of the quantity of the maltha added.

Captain Torrey asks me what should be the percentage of organic matter, not bituminous, admitted in an asphalt for paving purposes. I will answer this question by saying that it is well known that organic matter, not bituminous, is detrimental in asphalt pavement, and that its detrimental effect is in the ratio of the quantity found.

The question in regard to the solubility of bitumen soluble in caustic potash or soda, has been treated in my little article in the June issue of this magazine.

Quotation from Captain Torrey: "Prof. De Smedt says, 'preference should be given to the purer article, everything else being equal.' Is this to be applied to matters of cost to the contractor, or does it mean that it possesses preferable physical properties?" The inquiry of Captain Torrey is not reasonable, since I have already answered, in a previous reply, a similar question, and moreover, a continual answering of such questions would make our controversy monotonous and annoying to our readers.

Captain Torrey says he has never seen a C. P. asphalt, knowing it to be so. I will not discuss this, because he is only admitting ignorance on this subject. C. P. asphalt is sometimes even found in nature. Bermudez asphalt is C. P. after having been purified with bi-sulphide of carbon or chloroform. So that the captain, without knowing it, has seen C. P. asphalt.

The quotation by Captain Torrey from Prof. Richardson's Annual Report, in regard to the impurities in Trinidad asphalt, although correct, is misleading in this case. Captain Torrey says: "All these impurities are left in the refined asphalt." This is correct so far, but where Captain Torrey's statement is lacking and misleading is, that he neglects to mention that from 40 to 41 per cent. is already eliminated from the asphalt by the treatment with bi-sulphide of carbon or chloroform and that only from 1 to 2 per cent. is left, which is to be eliminated to obtain a strictly C. P. Knowing the nature of what is left in the asphalt (Trinidad) as to be sulphide of iron, and traces of alumina, and having at our disposition solvents of those compounds, without detrimental effect on the asphalt, it is easy enough to remove this small percentage of

impurities, although it is tedious work and for elementary analysis is unnecessary. The ashes, if any, are not mentioned, because I think it to be misleading, since one not acquainted with Trinidad asphalt might suppose that this small percentage found represents the only percentage of impurities existing in Trinidad asphalt; in fact, an elementary analysis of asphalt is not to show the percentage of impurities, but only the elementary constituents of the asphalt.

Captain Torrey's quotation: "Aside from these many impurities it is desirable information to know how to remove all the sulphur alone, unless that is included as an elementary part of any asphalt." The above quotation is positive proof of the lack of knowledge of Captain Torrey on this subject. Sulphur is not an elementary part of all asphalts, but it is an elementary part of sulphuretted hydro-carbons, such as the Trinidad asphalts, etc., and to eliminate the sulphur from such asphalts would mean their destruction.

Quotation from Captain Torrey: "It was observed in a former article that Prof. De Smedt gave no nitrogen or oxygen as in the composition of asphalt, according to his analysis." In my answer in regard to nitrogen in a former issue, the word "often" was omitted, which would make it read, "as a general fact the nitrogen is *often* eliminated as ammonia during the operation of refining." This was my meaning and my intention, which makes my saying correct.

Captain Torrey, because he discovers in several books analyses of asphalts in which oxygen and nitrogen are mentioned, finds fault with me for not mentioning the same in my analysis, and for not giving any impurities as results of my analysis. Here he shows ignorance again, and proves that it is not sufficient to consult some books to discuss the questions under debate, I will answer this at some length, with the hope that I may be better understood by my opponent.

We find the following in the Dictionary of Pure and Applied Chemistry by Ad. Wurtz—member of the Institute of France (Academy of Sciences): "Heretofore in proceedings of organic analysis, hydrogen and carbon were quantitatively found by one operation, and oxygen was counted by difference; thus by working on unknown substances, the presence of sulphur was often ignored. Sev-

eral chemists having remarked these mistakes, made by some of our great standard authorities, overcame the difficulty by direct analysis of the elements of the organic matter. It is since then that it has been discovered that several asphalts yield sulphur and no oxygen, consequently some asphalts are sulphuretted and not oxygenated." These innovations are principally due to M. M. Maumine, Stromeyer, Baumhauer, Ludenburg, Dr. Keyser, etc.

Captain Torrey seems not to keep pace with the progress of chemistry, and consequently is, therefore, excusable.

	Analysis by Boussingault.			Oxygen by difference.		
	C.	H.	O.	S.	A. Z.	Ashes.
	77.84	8.92	11.53		1.71	0.50
Direct analysis of all the elements by Dr. Keyser.	80.	9.		10.	0.40	0.60

The asphaltine of Mr. Boussingault is made by submitting bitumen purified by ether to a temperature of 250° C. for some time, and not as stated by Capt. Torrey.

Analysis of Boussingault's Asphaltine.

Dr. Keyser.		Mr. Boussingault.	
C. 74.25 H. 9.90 S. 15.84	Direct analysis.	C. 75 30 H. 9.90 O. 14.80	Calculated by difference.
99.99		100.00	

The asphaltine of Lebel and Munz is made the same way as the one made by Boussingault with this difference, that Lebel & Munz is not submitted to the temperature of 250 C. Lebel & Munz, out of courtesy to the eminent chemist, Boussingault, adopted the same name which is criticised by Captain Torrey.

Captain Torrey finds fault with the names "Asphaltine," etc., and says, "with the present knowledge of them it would be better not to use these misleading names, but others more appropriate." According to Captain Torrey's ideas on this subject it would become necessary to change some other names,—among them we find paraffine, vaseline, etc.

Captain Torrey says: "It is probable that the (natural) mineral ingredients confer excellencies for use, superior to anything obtainable by the artificial admixture of sand and dust, rendered necessary by their absence from an asphalt in its natural state." I proved in the Laboratory of the District, Washington, D. C., in the

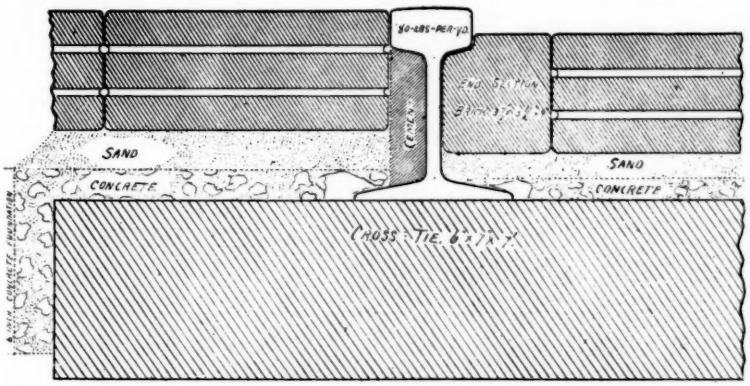
presence of Prof. Bowen, Prof. Richardson and official witnesses, that the artificial mixture is as good, if not better than the natural one in the Trinidad asphalt. And some time ago it was proved with suitable machinery in the presence of several chemists, engineers and experts, that the Bermudez asphalt paving mixture has a higher cohesion and crushing strength at all temperatures than the paving composition with Trinidad asphalt. So that the kind offer of Captain Torrey to test the Bermudez asphaltic cement, would be too much trouble for him, and would only confirm what we know about our asphalt.

E. J. DESMEDT.

E. J. De Smedt, Chemist.

THE T RAIL AND BRICK PAVEMENTS.

THE accompanying illustration shows a proposed cross-section of 80-pound T rail, with brick pavement, on six inches of concrete foundation. The Citizens' Street Railroad Company of Memphis has recently laid some 72-pound rail 4¾ inches high by 4¾



inches base, putting on the cross-ties, under base of rail, an oak block 1½ inches by 4¾ inches by 6 inches in order to get the requisite depth for brick pavement, fifty lineal feet of which they laid down in order to show the practical working and to demonstrate that a satisfactory and unobjectionable street rail and pave-

ment can be made with the two combined in the manner herewith proposed.

This short piece of pavement, as laid, is a neat and close-fitting job, and I think shows conclusively that the T rail, laid in the manner shown, with brick pavement, will not impede or interfere with street traffic any more than the tram or flanged rail. It seems to be almost impossible to maintain for any great length of time the Johnson or any other form of street rail when mounted on a chair, no matter how well laid and paved around. There is, however, no question of the fact that a Johnson rail center, bearing girder seven to eight inches high, spiked directly to the cross-ties, makes a superior street car track. *Niles Meriwether, C. E.*

THE FOUNDATION FOR BRICK PAVEMENTS.

Brick paving, while yet in its infancy, has passed the experimental period and is fast taking the place of all other pavements; and while it is not the object of this article to detract from or lessen the appreciation of other pavements, yet it is the belief of the writer that as brick, as a material for paving, becomes better known, and as the means to supply the demand are more and more developed, brick paving will be more called for and oftener specified, and that the time is not far distant when the main streets in our smaller towns and the principal country roads will be paved with brick as well as the streets in larger cities and towns.

It is but a few years since brick paving was somewhat of an experiment, and the kind of brick required, the method of laying, and the nature and amount of foundation were questions upon which good engineers might differ, and the tyro was compelled to use his best judgment and learn by observation and results. And while results are now in no ways doubtful, yet we have by no means reached perfection, and the engineer, contractor or manufacturer, who has any desire to obtain the best pavement, must not stop experimenting or studying results.

Like all other pavements much depends on the foundation, and

as we have had almost all kinds of foundations we ought to know something about what is best and most practical.

The early specifications called for foundations all the way from one with a six-inch "Telford" base and six inches of small macadam with two cushions of sand and a two-inch course of brick, to one where all the foundation called for was the natural soil to receive the four-inch wearing course of brick.

The kind and amount of foundation should be determined by the nature of the sub-soil and the cost of material. In a sandy sub-soil where brick suitable for lower course brick can be obtained cheaper than macadam, a two-course paving on sand with a sand cushion between courses is perhaps the best; but where the sub-soil is a loam, or clay, or refuse filling, a six-inch macadam foundation thoroughly rolled and compacted will give the best results; on and into this should be placed enough sand to fill all interstices and leave a cushion of sand at least one inch and not more than two inches in depth.

Concrete as a foundation is specified in many places, but the places where and the conditions under which it is superior to macadam are few, and then ofttimes the additional expense is not warranted by the conditions or the necessities of the case.

Whatever foundation is used, it is essential that not only the foundation, but the sub-soil as well, be thoroughly compacted and settled. If the sub-soil be sand this can best be done by flooding and tamping. If loam, or clay, or refuse filling, a heavy roller is a necessity, and the best results can be obtained with a ten or twelve ton steam roller. A "macadam" or "concrete" foundation may and should be rolled with fully as heavy a roller as the sub-soil or natural foundation. In a two-course pavement, the under course should be rolled with a hand roller, to settle the brick firmly in the sand. Whatever the foundation, there should be a cushion of sand under the top course of brick, at least one inch and not more than two inches deep.

For a wearing surface, brick thoroughly burned and vitrified, when made of clay adapted to the manufacture of paving brick, have proven superior to any other known substance that can be used in street paving. Costing less than granite or asphaltum, it

is less slippery and will outwear either, is less noisy than granite and costs less for repair than asphaltum.

From a sanitary standpoint, brick pavement is the nearest perfect of any, it is easily kept clean, is impervious to water, and does not decay.

A paving cement or pitch is sometimes used to fill the joints between the brick. It costs about twenty cents per square yard, and the paving is not enough better to warrant the additional expense. About the only claim of superiority that is made in its favor is, that it makes a water-tight joint, and the same thing is obtained with a sand joint after the street has been worn a short time.

The quality of brick to be used is of the utmost importance. There are several makes of brick that have had actual wear enough in street paving to prove their reliability, but the brick manufacturing industry is growing and spreading so far and rapidly that the engineer will ofttimes be asked to accept brick that has not had the test of actual wear. Any manufacturer that expects to sell brick to be put into paving should also expect to guarantee such brick in the pavement. Many of the brick being used could be safely guaranteed to last fifty years or longer.

The usual tests for paving brick are the crushing test, the absorption test and the abrasion test. The poorest brick used should not crush under less than 6,000 pounds per square inch, should not absorb more than 2½ per cent. of water in 24 hours, or lose more than 10 per cent. in five hours in a rattler used to clean castings running 30 revolutions per minute with ten times its weight of castings put in the rattler at the same time.

If we persist in demanding better brick from the manufacturers, better work from the contractors, and inspection from the engineers, the future will see the same or greater progress in the line of better and more satisfactory pavements than the past.

J. D. Wardle, C. E.

A SEVEN FOOT SINGLE RING BRICK SEWER.

THE construction of a seven foot circular brick sewer in the city of Springfield, Illinois, was commenced May 14, 1894, by Thomas White, contractor. The construction of this sewer is a little peculiar and out of the ordinary, inasmuch as the greater portion of it is constructed with a single ring of brick. This is probably the largest single ring brick sewer constructed of which there is any record.

There are 1,300 feet of sewer to be built, and of this about 200 feet will be double ring, as it is laid in the bed of an open waterway. The invert is formed with brick and stone masonry, with a 13-inch brick wall carried up one foot above the spring of the arch. The brick used in the single ring work are side cut shale pavers, and this portion of the work runs through a strata of firm yellow clay, the sides of the trench and bottom of the invert being very firm. The masonry is laid in one part of Louisville cement to two parts of sharp river sand. Concrete is placed between the sides of the trench and the brick work, two feet and four inches above the top of the invert, which greatly strengthens the only weak point in the sewer.

Considerable apprehension was felt by many of the contractors and others here as to the advisability of the construction of so large an arch with one ring of brick, but the writer is perfectly satisfied that this piece of work, constructed as it has been with first-class material and workmanship, will stand much longer than two rings of common sand brick, such as have been used here and in many other places.

This sewer is the main outlet for a large portion of the sewerage matter and surface drainage for the city, and at times is charged to its utmost capacity. When the work was first considered by the city council it was intended to make it double ring, but upon investigation it was found that the finances were not available for the construction of the entire work, and after considering the matter it was deemed advisable to make the single ring experiment, which will, I believe, prove entirely satisfactory. I would not, however, advocate the construction of all sewers of this dimension with a

single ring of brick, but in many localities they can be used at a great saving to the tax-payers.

The cost of this work is $2.64 for the single ring, $3.92 for the double ring and $11 per thousand for the extra brick masonry used, including excavation, which averages nine feet.

The engineering features of this work, aside from the general supervision, were very simple, and no serious difficulties were encountered. *C. M. Rickard, C. E.*

CURRENT INFORMATION.

ASPHALT TESTS AND COMPETITION IN PHILADELPHIA.

Dr. Henry Leffman, analytical chemist, and Dr. Samuel P. Sadtler, consulting chemist and expert, have submitted to the Citizens' Municipal Association and the Trades League of Philadelphia, by whom they were employed, a report of their investigations and tests of asphalts. Their report of their analysis of refined asphalts is as follows:

	Refined Trinidad.	Refined Bermudez.
Specific gravity at 60° F	1.378	1.071
Bitumen soluble in Carbon Disulphide	61.507 p.c.	97.22 p.c.
Mineral matter or Ash	34.51 "	1.50 "
Non-bituminous organic matter	3.983 "	1.28 "
Portion of total Bitumen soluble in Alcohol	8.24 "	11.66 "
Portion of total Bitumen soluble in Ether	80.01 "	81.63 "
Loss at 212° F	0.65 "	1.37 "
Loss at 400° F., in ten hours	7.98 "	17.80 "
Loss at 400° F. calculated to amount of Bitumen present.	12.812 "	18.308 "
Evolution of Hydrogen Sulphide at	410° F.	none at 437° F.
Softening point	160° F.	113° F.
Flowing point	192° F.	150° F.

"The manufacture of the asphaltic cement from the refined asphalt and oil residuum" they further report, "is carried out according to a method strictly prescribed and following written specifications in the District of Columbia. This method as applied to Trinidad asphalt will be found detailed in the report of the district commissioners for 1893, p. 158. In brief, it is to melt the asphalt at a temperature not exceeding 325° F., and then to add the oil residuum previously heated to at least 150° F., and by continued agitation to bring the mixture to the condition of a homogeneous cement. The sand, or mixture of sand and stone-dust, and the asphaltic cement are to be heated separately to about 300° F. The pulverized carbonate of lime while cold is mixed with hot sand in the required proportions and then mixed with the asphaltic cement at the required temperature (300° F.) and in the proper proportion in a suitable apparatus, so as to effect a thoroughly homogeneous mixture.

"In proceeding to make mixtures of asphaltic cement and asphaltic paving composition with Trinidad asphalt, we took the specifications of the department of public works of this city as our guide. These state, that 'the refined asphalt and residuum oil will be mixed in the following proportions by weight: Asphalt 100, petroleum 16 to 22. The asphaltic cement, made in the manner above described, will be mixed with other materials in the following proportions, by weight, viz:

Asphaltic Cement	13 to 16
Sand	58 to 63
Stone-dust	23 to 28
Pulverized Carbonate of Lime	5 to 8

"In making the Bermudez cement and paving composition, we took the proportions furnished us by Dr. De Smedt, the chemist of the New York and Bermudez Company. This was as follows: asphalt 100, oil residuum 11. This cement was then to be mixed as follows:

Asphaltic Cement	10.15
Sand	74.85
Pulverized Carbonate of Lime	15

"In comparing this with the composition of the Trinidad paving mixture, we notice such a dif-

ference that we determined to make up a mixture from Bermudez asphalt which, after taking into account the difference in mineral residue of the two refined asphalts, would bring them more nearly to an equality of composition. We therefore made a mixture of asphalt cement, composed as stated above, with a different proportion of sand and pulverized carbonate of lime. This mixture was:

Asphaltic Cement	10.15
Sand	59.85
Pulverized Limestone	30.00

"With these mixtures, hereafter referred to as 'Trinidad mixture,' 'Bermudez No. 1,' and 'Bermudez No. 2,' we determined to make tests of tensile strength, or rather, cohesive strength, at different portions and of compression tests at different temperatures.

"The composition of the mixtures may be expressed in percentage numbers with very close approximation to the figures given above, and the figures thus taken are entirely within the limits of the specifications referred to. The percentage composition then is:

	Trinidad. Per cent.	*Bermudez No. 1.* Per cent.	*Bermudez No. 2.* Per cent.
Asphalt	12.5	9.1	9.1
Oil Residuum	2.5	1.0	1.0
Sand	58.0	75.0	60.0
Crushed stone	23.2		
Pulv. limestone	3.8	15.0	30.1
	100.0	100.1	100.1

The report of the physical test is as follows:

	Trinidad Mixture. Pounds.	*Bermudez No. 1.* Pounds.	*Bermudez No. 2.* Pounds.
Cohesion Tests at 32° F.			
Broke at	138	453	480
"	155	345	537
Average	146.5	399	508.5
Cohesion Tests at 64° F.			
Broke at	53	103	206
"	58	130	202
Average	55.5	116.5	204
Cohesion Tests at 108° F.			
Broke at	20	12	37
"	18	28	52
Average	19	20	44.5
Compression Tests at 32° F.			
Ultimate strength.	4110	7000	7000
or per sq. inch	1027.5	1750	1750

The chemists say in their report:

"The question of the effect of water, and particularly of standing water, upon the several asphalt paving compositions was a matter that your committee wished particularly looked into. As to the effect of water upon Trinidad asphalt paving composition, the experience in Washington has been quite decisive, and except on streets where the gradient is considerable, and drainage therefore rapid, the gutters are ordered to be paved with vitrified brick or other similar material. From the reports of the district commissioners abundant testimony can be had as to their opinion on this matter based upon practical observations. Thus, in the Report for 1886–7, p. 65, we find in the discussion as to merits and demerits of coal tar distillate mixtures the following from Capt. Eugene Griffin, Corps of Engineers, U. S. A.: 'It can be laid from curb to curb, as it will not rot in the gutter, as does the asphalt. Asphalt pavements also disintegrate badly when weather cracks have formed, these acting as gutters to receive and hold the surface drainage.' In the Report for 1888–9 we find, under the head of specifications for standard asphalt pavement (see p. 189), mention of another expedient for protecting the asphalt composition in the gutters. It says: 'Where gutters are not paved with granite blocks or bricks, they will for a width of three feet be painted with No. 4 paving tar and ironed with hot smoothing irons. After the curb is set and pavements laid, hot paving tar will be poured into the joints of the curb until it rises and remains at the level of the pavement.'

"Mr. Clifford Richardson, formerly Inspector of Asphalt and Cements for the District of Columbia, in a report made to the Commis-

sioners, April 24, 1893, says "Bermudez asphalt possesses the decided advantage over Trinidad pitch of containing little organic matter of a non-bituminous nature and no soluble salts, and in consequence it is not attacked by water and would, therefore, not rot in the gutters as Trinidad frequently does." This statement, proceeding from abundant experience, is of special interest to the citizens of Philadelphia, who have recently suffered from excessive dust, owing to the contractors' fear of damage which might be done by water to Trinidad asphalt pavements by frequent sprinkling. The Bermudez asphalt appears to have the very important advantage of being less susceptible to damage by water.

"In the Report of the District Commissioners for 1893, p. 110, Mr. Geo. H. Bailey, computing engineer in charge of repairs and improvements to streets, says, "for the past year's work the practice has been generally followed of paving the gutters of asphalt roadways for a width of two feet with vitrified brick. The use of this material in such situations has proved very satisfactory, especially on streets with light gradients. It gives a surface about as smooth as asphalt and removes the danger of disintegration and decay occasioned by standing water on an asphalt surface."

"Some experiments were made by us on the question of the action of water upon the fragments of pavements before referred to. At ordinary temperatures, the Trinidad pavement composition shows after some hours a brownish color on the surface, and in the course of a day or two this is sufficient to rub off upon the fingers, when a fresh brownish film forms. This clearly indicates a surface disintegration. With the Bermudez asphalt composition no change in color appears, nor could any film be rubbed off after several days' standing. The several samples (Trinidad pavement from Market St. Bridge, Trinidad pavement from Broad and Arch Sts., and Bermudez pavement sent by T. H. Thomas from Washington) were also tested by two hours' immersion in water at 130° F. Under these circumstances the two Trinidad samples showed appreciable disintegration on the surface and left a sandy deposit in the beaker glass, quite recognizable as coming from the fragment tested. The Bermudez sample softened somewhat, but left no appreciable deposit due to disintegration. This test is more severe than any to which the street paving is likely to be subjected in ordinary use."

The conclusions of Drs. Leffman and Sadtler were set forth as follows:

(1) The analyses show that the Bermudez is a very pure bitumen, containing, as it does, 97.22% of material soluble in carbon disulphide. A large proportion of this is also soluble in ether, indicating a high percentage of the so-called "petroline" which gives cementitious value to compositions in which it enters. In both these respects it seems to be superior to Trinidad asphalt.

(2) The analyses show that the percentages of mineral and organic non-bituminous matter are notably less in the Bermudez than in the Trinidad asphalt. The absence of much mineral matter makes it possible for the Bermudez asphalt to make more paving composition than the Trinidad asphalt, taken ton for ton. The organic non-bituminous matter is an injurious constituent, and its presence in any quantity is undoubtedly largely responsible for the "rotting" and disintegration of the Trinidad pavement in street gutters.

(3) The tests of cohesive strength show that paving compositions can be made from Bermudez asphalt that are stronger at all temperatures than the composition of Trinidad asphalt now being used in Philadelphia, and are equal if not superior to the Trinidad asphalt composition as used in Washington.

(4) The compression tests also show a

distinct superiority for the Bermudez asphalt compositions as made by us over the Trinidad asphalt composition in use in Philadelphia.

(5) The experience in Washington, as well as our own experiments, show that the Trinidad asphalt pavements are gradually disintegrated by the continued action of moisture, particularly where water stands for a time in contact with the surface, as in the gutters. In our experiments the Bermudez asphalt composition seemed to be affected notably less, a difference we attribute to the presence of soluble salts and organic non-bituminous matter in the Trinidad.

We therefore believe that your committee is abundantly justified in urging upon the municipal authorities the opening of sheet-asphalt paving in Philadelphia to parties using Bermudez asphalt. It is surely the best municipal policy to utilize a material which promises so well under severe tests to effect an improvement in the quality and durability of such pavements, and we need not point out the fact that competition will tend to secure these advantages, coupled with a reduction in cost.

Lewis M. Haupt, C. E. and T. B. M. Addis, an agent of the Citizens' Municipal Association, in a report appended to that of the chemists, express the opinion that competition will "save at least 50 cents per square yard." They also say: "Our existing specifications permit the use of a four-and-a-half inch base of broken stone without cement. This is one of the main causes for the rapid disintegration of the asphalt pavements here, as well as for the large expenditure for repairs, and should be discontinued. We would recommend that a concrete base be required under all asphalt pavements, as is now done in Washington."

Dr. N. Wiley Thomas, who represented Director Windrim at the tests by the chemists, asked for information as to the relative properties of the several ingredients used in the mixtures tested, but was told that it had been decided by the committee that this should not be given before the publication of the report.

PROF. BOWEN'S COMMENTS.

Commenting on the report of Messrs. Leffman and Sadtler, Prof. H. C. Bowen writes:

The report seems in part to have been piloted by interests other than independent and scientific investigators. They admit a main cause of rapid disintegration of Philadelphia asphalt pavements to be the poor 4½ inch base laid without cement. The investigation was conducted in three ways, as follows:

(1) Chemical.- It is not a proper conclusion by these experts (in other matters than asphalt) that one asphalt is better than another because soluble to a greater degree in bisulphide of carbon. This reasoning would put coal tar ahead of asphalt.

As to composition of Bermudez (Venezuela) asphalt No. 2 we find that 90 per cent. of sand and dust had to be added to bring it to the same state as Trinidad pavement. The Trinidad asphalt contains a natural fine grit which is an advantage it possesses over the Bermudez.

The tests indicate a difference of 1.6 soluble in ether, and the strange inference is drawn that Bermudez containing more petroline is therefore more cementitious.

The conclusion is drawn that non-bituminous matter in Trinidad asphalt causes rotting in gutters. The very limited tests of these "analyses" warrant no such conclusion.

Every observer of the Trinidad asphalt lake knows that pools of water stand on the lake for years, and that the asphalt itself from under this water shows no absorption of water. Moreover, the water is fresh and sweet, and is used by the people on and around the asphalt lake for drinking.

The chemical analyses and data given, beginning with "specific gravity" and ending with "flowing point," seem to have been incorporated from those of the chemist of the Bermudez Co., and not to have been made by any one of the experts of this report.

(2) Physical Tests.—All who have studied in a practical way the subject of asphalt paving and the demands of traffic upon it know that crushing and tensile strength are not very important. These tests do not indicate the kind of asphalt pavement which will endure traffic nor fulfill the needs of a pavement. No one doubts that a rubber surface fixed to a firm foundation and having a proper yielding and recovering power and toughness, would make a good pavement. Yet its capabilities can not be determined by crushing and tensile tests.

It is not proper nor possible to make "bituminous concrete briquettes" of like composition and equal compression as undertaken in these tests, and thus compare

the qualities of the different kinds of asphaltum (pure) by this plan. Exact conditions are imperative.

It should be noted that the Bermudez mixture contains 24 per cent. more asphaltum than that in the Trinidad sample. For the 12.5 grams of refined Trinidad is closely 57 per cent. asphaltum, whereas 9.1 grams in the Bermudez is 97 per cent., consequently the asphaltum involved stands 7.1 per cent. in the former to closely 8.8 per cent. in the Bermudez. The conclusions drawn, that the higher the tensile and crushing strength the better the asphalt, are evidently too hasty. What would have been the result if coal tar had been used? They would have found higher figures than for Trinidad and Bermudez briquettes, notwithstanding it is well known that coal tar is inferior to Trinidad asphalt for paving.

(3) Inspection.—This inspection by "experts" disclosed imperfections traceable to imperfect workmanship, depressions and elevations, uneven surface, rotting gutters, things found in pavements of the past. The report fails to mention the possible effects of defective workmanship and bad compoundings, which must appear in building the many miles of pavement while the industry was developing. Rotting of Trinidad pavement is scarcely known to-day. The gutter construction is now carried to a high degree of durability. The facts which are supposed to be brought out in this pamphlet rest on frail foundations. The resistance of asphalt pavement to street traffic and conditions is due to properties of asphalt other than those considered by the experts.

H. C. Bowen, Chemist.

Columbia School of Mines, New York, June 18, 1894.

PROF. RICHARDSON'S COMMENTS.

Prof. Clifford Richardson, to whom reference is made in the report of Drs. Sadtler and Leffman, in a letter commenting on their statements, says:

Tests for tensile strength of briquettes of Trinidad and Bermudez asphalt surface mixtures are very deceptive, because the asphaltic cement is but one factor in the physical properties of the briquette and of the result of the tests, while the size of the sand, the amount of impalpable dust in use and the density of the briquette are much larger, more important and more controlling elements.

I have, during the past two years, made extended physical and chemical tests of the two asphalts under consideration, including a number for tensile strength at different temperatures. The results of tensile strength tests, it was found, could be made to appear either in favor of the one or the other asphalt in accordance with the conditions employed in making the briquettes. The principal factor in influencing the results is the density which is obtained in the briquettes. With high density, Trinidad asphalt will give slightly higher results. With low density the reverse is the case. In the Philadelphia experiments the density of the test pieces is not given, and it is therefore impossible to judge the results properly. The accompanying tables, which give the results of tensile strength tests of surface mixtures of Trinidad and Bermudez made in this laboratory show quite a different state of affairs (especially in connection with Trinidad asphalt) from the results obtained in the laboratory of Messrs. Booth, Garrett & Blair.

Where surface mixtures of Trinidad and Bermudez asphalt cement were made under uniform conditions, it was found that, with very thorough compaction, and a consequent high density, that both mixtures have almost the same tensile strength at low temperatures, while at high temperatures those of Trinidad asphalt withstand a greater strain. If the briquettes are, however, not well compacted, the results are the reverse. This is due to the less viscous nature of the Trinidad cement, which, in mixtures not thoroughly compacted, would not withstand tensile strain as well as the more viscous Bermudez. In a street surface, which was so laid as to receive its ultimate impression, there would be no preference for either asphalt in tensile strength at low temperatures, and a small one in favor of Trinidad at high temperatures.

The Philadelphia tests of tensile strength seem, in the light of my experiments, to be not fairly suited for comparison of Trinidad and Burmudez cement. Granting, however, that the Philadelphia results are correct, their interpretation by the experts is erroneous. This will appear from a study of the nature of bituminous cement in general in connection with the tests for crushing strength.

If the experts had added glance pitch, coal tar or even land pitch to their series of experiments, they would have found that these materials, which are recognized as being worthless for paving purposes, would have a greater tensile and crushing strength than either Bermudez or Trinidad lake asphalt.

In the following tables I submit the results which were obtained in the course of my investigations to illustrate this point:

Average Tensile Strength of Asphalt Surface Mixtures.*

	Trinidad at			Bermudez at		
	40°F.	77°F.	100°F.	40°F.	77°F.	100°F.
	Lbs. per sq. in.			Lbs. per sq. in.		
Series 1, 1892.						
Dense	477	177.5	61	406	157	50
Series 2, 1894.						
Less dense	431	131.	..	543	162	..
Series 3, 1894.						
Densest.	604	205.	..	611	171	..

* 10% dust and Washington sand in all mixtures.

Average Tensile Strength of Asphalt Surface Mixtures,* with Varying Proportions of Limestone Dust.

Dust.	Tensile strength at 38° F.		Tensile strength at 77° F.	
	Trinidad.	Bermudez.	Trinidad.	Bermudez.
%	Lbs. per sq. in.		Lbs. per sq. in.	
7.5	501	449	188	111
10.	604	611	205	171
15.	646	662	273	186
20.	701	857	270	192

Average Comparative Crushing Strength of Surface Mixtures* of Coal Tar, Trinidad Lake and Land Asphalt, and Bermudez Asphalt.

	Density.	Crushing strength At 38°F.	At 77°F.
		Lbs. per sq. in.	
Coal Tar, 15%	2.16	3,880	1,254
" " 10%	2.07	3,845	2,655
Land pitch, 10% bitumen.	2.13	1,813	761
Bermudez cement, 10% bit.	2.10	1,955	635
10% bitumen	2.06	2,125	550
Lake pitch, 10% bitumen..	2.14	1,375	548

* 10% dust and Washington sand in all mixtures.

It will be seen that the conclusion that the cementing material which gives the greatest strength in bituminous concretes must be the most valuable one for paving purposes, based upon our methods of interpreting similar tests with hydraulic cement concrete, is entirely incorrect. We find that coal tar, which is of no value for paving purposes, gives a very much higher crushing strength than any of the other bituminous cements and that land pitch, which has been proved to be inferior, resists crushing better than the live lake asphalt. We are dealing with viscous materials, the most viscous being the most brittle and least suited for paving purposes. The best cementing material is the one which, with the least viscosity, at a proper consistency for use as a paving cement, will still resist impact at all temperatures, not being too soft at high or too brittle at low. Those which become brittle at low temperatures give, like hydraulic cements, high tensile and crushing tests, while the best for paving purposes continue to yield even at 32° F., and consequently, although having life and cementing power at that temperature, give lower results for crushing and tensile strength than the more viscous and brittle tar and land asphalts. The true deduction, then, from the expert figures, is that at both temperatures given Trinidad asphalt is the most yielding and would resist impact better, and consequently prove a more valuable cement for paving purposes.

As to the report of the experts in regard to the inspection of Washington pavements, the conclusions drawn seem to show a lack of understanding of the conditions there existing. They could see no Bermudez surface that was even a full year old, and yet they compare this with Trinidad pavements that are cracked because they have been down for years. No lake asphalt surface can be found in Washington of the same age as Bermudez surface, which shows a crack or defect.

The final conclusions and objections of these gentlemen may be quoted and replied to paragraph by paragraph, as follows:

1. The analyses show that the Bermudez is a very pure bitumen, containing, as it does, 97.22% of material soluble in carbon bisulphide. A large proportion of this is also soluble in ether, indicating a high percentage of the so-called "petroline," which gives cementitious value to compositions in which it enters. In both of these respects it seems to be superior to Trinidad asphalts.

The purity of the bitumen is of no importance technically. It must eventually be mixed with mineral matter, and all the impurities become at once a part of the mineral aggregate. The relative amount of petroline is not essentially different, 80.01 for Trinidad and 81.63 for Bermudez, according to their own figures. In the light of my experience I can see no way of basing a conclusion on these grounds that Bermudez is essentially superior to Trinidad asphalt for paving purposes.

2. The analyses show that the percentages of mineral and organic non-bituminous matter are notably less in the Bermudez than the Trinidad asphalt. The absence of much mineral matter makes it possible for the Bermudez asphalt to make more paving composition than the Trinidad asphalt, taken ton for ton. The organic non-bituminous matter is an injurious constituent, and its presence in any quantity is undoubtedly largely responsible for the "rotting" and disintegration of the Trinidad pavement in street gutters.

The mineral matter in Trinidad asphalt is an impalpable, sharp quartz sand, intimately and homogeneously mixed with the bituminous constituent. This sand is one of the valuable features of the pitch, and when absent, as in the Bermudez asphalt, must be made up by the addition of ground limestone, or other impalpable dust, which can not be done with that uniformity in the gross paving mixture that is found in the natural product, although such an intimate addition can, perhaps, be made in the laboratory.

The small amount of "organic matter not bituminous" in which, according to the analyses of the experts, Trinidad exceeds Bermudez asphalt, 2.7 per cent., can hardly be of any great injury when mixed with the 90 per cent. of the mineral aggregate in the surface. Further researches, soon to be published, have modified some of the conclusions which I drew in the early days of the industry and show that this is an unfortunate name and should be changed, for reasons which can not be entered upon here. It appears that a portion of what was originally considered non-bituminous organic matter is really material which was soluble with difficulty in the cold solvents which were used until lately. I have become convinced, from my experience, that the rotting of gutters, which is at-

tributed to the non-bituminous organic matter in Trinidad asphalt, is really due to lack of compaction and density; and I can show many gutters of Trinidad asphalt which, having been properly laid and compacted, are in good condition after years of use. Of course many poor gutters, due to bad workmanship, give way.

3. The tests of cohesive strength show that paving compositions can be made from Bermudez asphalt that are stronger at all temperatures than the composition of Trinidad asphalt now being used in Philadelphia, and are equal, if not superior, to the Trinidad asphalt composition as used in Washington.

4. The compression tests also show a distinct superiority for the Bermudez asphalt compositions as made by us over the Trinidad asphalt composition in use in Philadelphia.

My answer to the above conclusions has been already given. The results, if of any value, are in favor of Trinidad, since it is more yielding at all temperatures than the other bituminous cements and will consequently withstand impact better, although giving lower results with the testing machine.

5. The experience in Washington, as well as our own experiments, show that the Trinidad asphalt pavements are gradually disintegrated by the continued action of moisture, particularly where water stands for a time in contact with the surface, as in the gutters. In our experiments the Burmudez asphalt composition seems to be affected notably less, a difference we attribute to the presence of soluble salts and organic non-bituminous matter in the Trinidad.

After an experience of many years with Washington pavements, I would challenge the experts to show in that city a Trinidad asphalt surface of the same age as that laid with Bermudez cement which is in the most minute degree affected by water. In this last conclusion the experts have again compared old Trinidad surfaces with those of Bermudez asphalt which are not yet a year old. Experience extending over only a few weeks or even months with the latter material will not demonstrate its capabilities of resisting water better than Trinidad asphalt.

The entire conclusions advanced in the report which I have reviewed seem to me, therefore, to have the appearance of being drawn by advocates of Bermudez asphalt rather than by the careful scientific investigator. I should not be willing, after many years' experience with asphalt and a two years' study of Bermudez material, to draw such sweeping conclusions in regard to the two materials as the Philadelphia experts have done from the experience of a few weeks, experts too, who, although known to me personally to be gentlemen of high scientific ability, I have never heard of before as being in any way associated or having had any experience with the asphalt question.

In conclusion, I do not wish to be considered as an advocate of Trinidad asphalt as preferable to Bermudez. The merits of the two asphalts are still under investigation and must be settled chiefly by the lapse of time. Experience has shown us that asphalt pavements can be made with Trinidad Lake pitch which will last for years. This may be the case with Bermudez asphalt, but it has not been proved.

Clifford Richardson, Chemist.

Washington, D. C., June 13, 1894.

REPORT OF THE BALTIMORE STREET PAVING COMMISSION.

The Baltimore street paving commission, appointed by authority of the council in last October, to gather information regarding street paving in New York, Philadelphia, Boston, Washington and Buffalo, has submitted a report to Mayor Latrobe. The recommendations of the commission are as follows:

"1. That all streets paved, all streets repaved and all repairs of asphalt and asphalt block pavements be made by contract after due advertisement. We find this method carried out in all cities visited, and under proper inspection the results are very satisfactory. The paving of streets in this city with granite blocks by hired labor adds much to the labors of the small office force of the city commissioner, without compensating results in the character of the work done or reduction in cost.

"2. That repairs to all pavements except asphalt, asphalt block, and the construction and repair of macadam roads, be made by hired labor, unless the repairs constitute a repaving. This method is followed in all the cities visited, except Philadelphia. It enables repairs to be made promptly and prevents disputes which must necessarily arise under any contract for this kind of work.

"3. That no new or original pavements be laid except with asphalt,

asphalt block, granite or brick. We find that cobble and rubble pavements are no longer being laid in any first-class cities. The cobble and rubble removed from the streets can be used for gutters in the suburbs or otherwise disposed of by the city. We would except from this provision macadam for suburban roads.

"4. That sheet asphalt pavements be laid upon either a six inch concrete base, a four inch concrete base, or the existing pavements of cobble and rubble. The six-inch concrete base we find is the standard sheet asphalt pavement laid; but good results at reduced cost are attained by the use of the four-inch base upon streets not subject to heavy travel, and, also, by paving with asphalt over cobble, rubble and macadam. A crown of six inches, for a roadway thirty feet wide, we do not find excessive for paving over cobble, etc.

"5. That asphalt block pavements be laid upon the natural foundation of the roadway, properly rolled, if of satisfactory material; otherwise upon a bed of gravel, properly rolled, at least five inches thick. The former practice we find gives good results where the natural foundation consists of sand or gravel, and the latter where the foundation is clay or loam.

"6. That the foundation of granite block pavements, except upon the most heavily traveled streets, be prepared as described for asphalt blocks, and that the joints be filled with clean gravel and be pitched with coal tar, paving cement, or grouted with Portland cement.

"We find that the best paving cement has added to it about 10 per cent. of Trinidad asphalt. The best granite block pavements are laid upon a concrete base; we do not recommend this base simply on account of its cost, taking in consideration the very limited area of good pavements in this city as compared with the others visited. This also applies to asphalt block pavements.

"7. That all brick pavements be laid upon a concrete base, at least four inches thick, and have joints grouted with cement. Cement is preferred on account of the tendency of coal tar to run in hot weather.

"8. That the foundation for all pavements, after being properly graded, be rolled with a roller weighing not less than five tons.

"9. That all pavements be guaranteed and kept in repair for five years by the contractor under such bond or retain as seems best.

"We recommend the wording of the guarantee in the Buffalo specifications. It is probable that a bond would be equally as satisfactory from a reliable contractor, and add less additional cost to the pavement than a retain. We do not recommend a longer guarantee, as it has not yet been satisfactorily determined what the allowance per square yard should be for maintaining pavements after the end of five years. The city of Omaha has a contract with the Barber Asphalt Paving Company for keeping pavements laid by them in repair for ten years following the period of guarantee for eight cents per square yard per year, and we were informed that a perpetual guarantee was offered the city of Buffalo at the same rate. The five year guarantee should not materially increase the cost of any pavement, as the repairs on a well-laid pavement during this period are very slight.

"10. That specifications now requiring the use of Trinidad lake asphalt be worded so as to allow the use of "any other asphalt which

has been found by experience equally as good for paving purposes." While we do not believe in experimenting with any untried material, we find that different cities are experimenting with several different kinds of native and foreign asphalts, one or more of which may be found equal to the Trinidad. If considered advisable, additional bonds may be required of the competitors guaranteeing to replace the pavement with Trinidad, should this pavement prove inferior to those laid with Trinidad asphalt within five years. A guarantee of this nature was given by Mr. Thomas, who laid some pavements of Bermudez asphalt in Washington last year, and he further guaranteed that the cost of repairs should not in ten years exceed the cost of Trinidad asphalt pavement laid the same year.

"11. That smooth pavements be laid wherever possible. The best paved and swept cities we saw, on our tour of inspection, were those having the largest area of smooth pavements. The advantages of these pavements seemed to be best appreciated by the citizens of Buffalo, where they are laid upon the petition of and at the expense of the property owners. We found these pavements laid upon many streets where there was hardly a dwelling on account of the increase in value they gave to the abutting lots. In the suburbs of Washington there are also many streets paved at the expense of the property owners who desire these improvements and could not get them out of the general fund for several years. Other pavements were laid in Washington by the property owners paying one-half the total cost in advance, and at present an effort is being made to secure a law whereby a pavement may be laid and assessed against the abutting property whenever over one-half the abutting property is represented by a petition for the same. In Buffalo the petition must be signed by a majority of the resident owners representing at least two-fifths of all foot frontage. The best streets for smooth pavements are those unobstructed by street railway tracks and having a grade not exceeding four per cent.

"12. That all underground work and sewer and water connections be laid before a street is paved, and that no new pavement be disturbed for one year after its completion. These provisions are enforced in Philadelphia, Buffalo and Boston, and legislation covering the same ground is now being sought in Washington. The advantages are obvious.

"13. That no street be opened for any purpose without a permit and a deposit sufficient to cover the cost of repairs. This is the practice followed in New York and Washington and to be enacted in Philadelphia. In Boston and Buffalo a permit and bond are required, but the results are not so satisfactory.

"14. That upon future street railway extensions, a full grooved girder rail shall be used upon all paved streets. This rail was adopted by Congress for the streets of Washington and has given great satisfaction.

"15. That the cost of the new granite curb, which constitutes part of the sidewalk, be assessed against the abutting property.

"16. That the repavement of streets be made in accordance with the definite plan prepared in advance, showing the character of the pavement proposed to be laid upon each street and the order in which streets should be paved. If deemed advisable, a board could be ap-

pointed to draw up this plan and revise the specifications to conform to the best practice of other cities."

The commission appends to its report the following table of statistics as to the area of the different kinds of pavements laid in the cities named:

RELATIVE AREAS OF DIFFERENT PAVEMENTS.

	New York. Per cent.	Philadelphia. Per cent.	Boston. Per cent.	Buffalo. Per cent.	Washington. Per cent.	Baltimore. Per cent.
Granite and trap	81.6	19.5	29.5	....	14.7	4.5
Cobble and rubble	0.3	56.4	0.7	....	7.7	92.5?
Sheet asphalt or tar	8.9	6.8	1.5	55.8	57.3	1.4
Asphalt block	....	1.7	0.2	1.1	7.0	1.5
Vitrified brick	....	5.8	0.1	0.1	0.1	0.1
Macadam	9.2	9.8	68.0	0.4	13.2	....?
Medina sand stone	....	....	....	42.7	....	....?
Total	100.0	100.0	100.0	100.0	100.0	100.0

The commission also furnishes a detailed report of the information gathered in each of the cities visited.

EXPERIENCE WITH THE T RAIL IN SEVERAL CITIES.

A special committee, appointed by the common council of Saginaw, Mich., to investigate in other cities the use of the T rail for street railroad tracks in paved streets, after investigating and examining the matter in Port Huron, Detroit, Toledo, Columbus, Springfield and Chicago, has submitted the following report:

Port Huron—In this city all street car tracks are laid with a forty-five pound T rail, ordinary railroad section, laid on a 5 x 5 inch longitudinal pine stringer; this laid on ties spaced three feet from center to center. The space on the outside of the rail, between the rail head and flange, is filled with a 2 x 2 inch pine strip, and the pavement laid against it, and the top flush with the top of the rail. On the inner side of the rail the space is filled with a 2 x 2 inch oak strip, laid about one inch below the top of the rail, and the pavement laid against it, and crowning to the center between rails to the top of rails.

When the track was laid in the new pavements, and in conjunction with the laying of the pavements, the pavement is in good condition, and the T rails offer no obstruction to the free use of vehicles of that part of the street occupied by railroad tracks. Where the tracks were laid in the old pavements the pavement between the tracks is rough and rutted along the rail, so that in many places it is dangerous to turn out of the track when driving upon it, though it offers no more obstruction in crossing the track than in crossing many other parts of the same part of the street. The tracks are in good condition for a rapid transit street railway system.

Detroit—Prior to 1892 all street car tracks were laid with the flat top rail, either of girder or strap section (the top of rail about the same as in use in this city). May 27, 1892, the following ordinance was passed and adopted:

SECTION 1. It is hereby ordained by the people of the city of Detroit, that whenever any street railway track shall hereafter be constructed or reconstructed on any paved street, or on any street then being paved or repaved, the same shall be laid with girder grooved rails. Said rails shall not be of less than 77½ pounds weight to the lineal yard, and of improved pattern and style, with groove on inner side of the rail, the upper surface of the inner head of the rail to be not more than one-quarter of an inch below the upper surface of the outer head of the rail.

All work shall be done under the supervision of the board of public works.

Under this ordinance the 77½ pound grooved rail has been laid in parts of Woodward avenue, Gratiot avenue, Michigan avenue and Champlain street, in conjunction with the paving of those streets and avenues with asphalt, brick, granite and cedar block pavements, with no special care to fit the pavement close against the web of the rail.

The pavement is laid close against the head or tread of the rail, and the space against the web filled with cement grouting.

The rail is six and one-fourth inches high and four inch base laid on a tie plate spiked to white oak ties, laid about three feet from center to center, and the rail is connected every eight feet with cross rods 1 x 1½ inches in size, to preserve the gauge of the track, which is very important with this section of rail.

This section seemed to offer but very little obstruction to the use of the street for vehicles.

Toledo—All the rails used in this city for street car lines are the common flat top rail with a tram of one and a half inches in width, and the pavement is generally laid level with the top of the rail, which forms a groove on the tram of the rail one and a half inches wide and one inch deep, which makes it very objectionable for public travel.

Columbus—All the street car tracks in this city are laid with the flat top rail with narrow tram, except a short piece of groove girder rail, just laid in repairing the track on one of the principal streets. This section is about the same shaped groove and top as the Detroit section, and is nine inches high and weighs ninety pounds per yard. The flat top rail generally in use is a girder section weighing forty-six pounds to the yard, laid on chairs to elevate the rail above the pavement foundation, but this section is found to be too light to stand up under electric motor cars, and is being replaced by a seventy pound rail of the same section except it is six and one-fourth inches deep. An ordinance has recently been passed by the council of the city granting a suburban electric line the right of way through the paved streets of the city, and the board of public works and city engineer have given permission to use a T rail, the space on the outside of the rails to be paved closely with paving brick.

Springfield, O.—All the street car lines in this city are laid with the T rail section, except a few blocks of the old flat rail originally constructed for horse car lines. Most of the rails used are the ordinary railroad T rail section, weighing fifty pounds to the yard. One street, which is now being paved and a street car track being laid in it is being laid with the electric welded T rail known as the Johnson street railway T rail, weighing sixty-two pounds to the yard.

The T rail tracks laid in this city are laid in paved and dirt streets. When laid in brick pavements the bricks are laid close to the head of the rail on the outside of the track level with the top of the rail and between the rail one-half inch below the top of the rail and crown to the center of the track, level with the top of the rail. On dirt and gravel streets the space between the rails and along the outside of rails is filled with dirt and gravel same as rest of the street. There is no planking or paving between the rails on unimproved streets.

All the T rail tracks in this city are in good condition both for the street car company and the public

using the streets, and the T rail where laid in brick pavement offer as little obstruction to the use of the public to drive upon or across as any section of rail in use.

Chicago—All the street car tracks in this city are laid with the girder rail five to six inches high, with a three-inch wheel tram. This width of wheel tram is specified by the commissioner of board of public works for all street car tracks.

This width of tram is adopted to prevent the wheels of heavy loaded wagons from cutting a rut along the inside of the rail. The street car tracks are used for driving upon the same as any other part of the street, as the streets are generally crowded from curb to curb with buggies, wagons, carts and street cars, so the paved portion of the street is all occupied, so it is necessary that the street car tracks be constructed like tram roads as well as for street cars.

"One thing which was forcibly brought to the attention of your committee is that, if the public have rapid transit which they so much demand and should have, that teamsters driving with loaded wagons and other vehicles can not have the free use of the street car tracks for a roadway, only to the detriment and impediment of the street car service; and when the streets are paved as wide as they are in this city, the sooner the public driving carriages and wagons and vehicles of all kinds are educated to understand that they have no business driving in the street car tracks except to cross them, the sooner we will have rapid transit, better and more reliable street car service, better and smoother street car tracks to ride over.

"In the judgment of your committee there are only two sections of rails that should be permitted to be laid in our wide paved streets, and these are the street railway T rail, and the full groove or English groove girder rail. Either of these sections can be used, we believe, with perfect safety to the public using the street, and if properly laid will make a good street car track.

"If the street railway T rail is used it should be not less than sixty pounds to seventy pounds per yard and 5¾ inches high with the paving brick or blocks, shaped to fit close to the web of the rail and half an inch below the top of the rail on the inside, and level with the top of the rail on the outside.

"If the grooved rail is used it should weigh not less than seventy to eighty pounds per yard, and the paving fitted close around the head and web of the rail.

"While a lighter section of rail than these mentioned may be amply strong for the motor cars now in use, it is only a question of a short time when the lighter sections will be found inadequate in strength to carry the heavy motor cars and loads placed upon them. As the tendency is to use larger, heavier and stronger cars, which will carry heavier loads, and this increased rolling load will at the same time demand a heavier rail and more permanent track to sustain the weight placed upon it, it is necessary at this time to provide a rail section that will be ample in strength and rigidity, not only for the present but for the future, to prevent the destruction and waste to both the street pavements and the tracks of the street car company, in renewing its tracks."

REPORTS OF MUNICIPAL OFFICERS.

In the annual report of William Steyh, city engineer at Burlington, Ia., for the year ending March 31,

1894, he says that during the year 27,479.9 square yards of brick and 400 square yards of stone block pavement have been constructed and 9,551.1 lineal feet of curbing set, at a cost of $50,031.03. The report says:

"Of the various pavements constructed up to date we have macadam, 164,693; brick, 163,742; limestone block, 58,735, and granite, 3,628 square yards. Expressed in miles, macadam, 7.40; brick, 7.22; limestone block, 1.54, and granite, 0.11; making a total of 16.27 miles. The total length of curbing is 122,-217 lineal feet or 23.15 miles."

Of sewers, Mr. Steyh says: "During the year 7,313 lineal feet of sewers, 31 catch-basins and 22 man-holes have been added to the sewerage system at a total cost of $14,887.22. The total cost of the entire sewerage system to date, not including maintenance and repairs, is $187,145.07."

The annual report of Charles V. Mehler, city engineer at Louisville, Ky., gives a statement showing the work done on streets constructed and reconstructed from September 1, 1892, to September 1, 1893, in both the eastern and western districts. A summary of the work shows it to be as follows: Eastern District — Granite streets, 0.280 miles, $12,945.63; vitrified brick streets, 1.786 miles, $71,014.45; macadam streets, 0.072 miles, $2,-191.80; bowlder streets, 0.138 miles, $4,944.58; grading streets, 0.400 miles, $3,121.66. Total, 2.676 miles, $94,218.12. Western District—Brick streets, 2.996 miles, $129,824.02; granite streets, 0.318 miles, $3,499.17; grading streets, 0.079 miles, $849.32. Total, 3.393 miles, $134,172.51.

The annual report of Commissioner Jones, of the Department of Public Works, at Chicago, shows that during last year 139.46 miles of streets were improved and 350,-867 square yards of pavement repaired; 134,112 miles of sewers were constructed, giving the city a total of 1,144.78 miles; 74.59 miles of water-pipe were laid, making a total of 1,473.75 miles now laid in the city. Contracts for public improvements were made which incurred an expenditure of $7,178,-713.84. The receipts of the department were $14,217,214.70, of which $182,565.44 remains unexpended.

The fourth annual report of Rolla W. Roberts, city engineer at Saginaw, Mich., gives the total length of streets improved during the year, by paving or macadamizing, at 3.202 miles, at a cost of $50,682.01; 6.722 miles of sewers were constructed at a cost of $64,361.18.

In his sixth annual report to the board of water commissioners at Little Falls, N. Y., Stephen E. Babcock, chief engineer, says, that the waste of water was enormous throughout the town is attested by the large number of taps or outlets out of repair and leaking, reported by the inspectors. As a remedy for this, Mr. Babcock says: "The only positive correction for the evil of water waste lies in metering the entire consumption. This however involves quite a large expenditure for the first cost of meters, the expense of repairs and increased expense of inspection and registration of amounts of water used. The meters would require a monthly inspection throughout the year and also quite a reserve supply of meters to take the place of meters out of repair. With the cheap water of a gravity supply it would seem to be the better economy to annually in each year maintain a constant inspection during the months of July, August and September, and

also there should be several 3 and 2-inch meters kept in stock by the water commissioners to take the place of consumers' meters out of repair temporarily and while the consumers' meters are being repaired. With the adoption of this plan it is believed that the daily consumption can be kept down to 150 gallons per capita, including mill uses."

During the year 1893, the city of Philadelphia spent about two and a quarter million dollars for street paving, and the street railway companies about two million dollars. The report of the commissioner shows that the city laid fifty miles of paving in the city and fifteen miles of macadam in the outlying districts. In addition to this, about fifty miles of repaving was done by the railway companies. The paving was as follows: Granite blocks, 20.4 miles; sheet asphalt, 16.4 miles; vitrified bricks, 9.5 miles; granolithic, 4.7 miles; macadam, 15.3 miles; total, 63.3 miles. The commissioner of highways says, in his report: "The department, from observations of the durability and fitness of materials used by the city in street paving, has recommended to the committees of councils the selection of Belgian block for streets subject to heavy traffic, and on steep grades; sheet asphaltum for business and residence streets; vitrified brick for suburban streets and for city streets not subject to heavy travel."

A NOTABLE INSTANCE IN STREET PAVING.

A revolution has been brought about in making street improvements, at Bridgeport, Conn. Nine years ago the system was very defective and incomplete. Money was generously appropriated to the street department by the city, but the improvements undertaken lacked method and permanent character. Work done upon the streets one year had to be repeated the next year. The streets were said to be the worst in New England, and it was claimed that even the rural towns in Massachusetts would refuse to tolerate, for ever so brief a period, the ill-conditioned streets that constituted Bridgeport's main thoroughfares. Nine years ago the present board of public works was created, and this board elected for street commissioner Mr. B. D. Pierce, a man who had acquired valuable knowledge and skilled experience in the construction of streets. Under the direction of the board, so far as they had suggestions to make, but mainly from methods of Mr. Pierce's resulting from his previous practice, was begun a system of street improvement, which, at the end of each year, gave them not only a good permanent improvement, but one that could be extended each year. At the time that this board of public works and Mr. Pierce came into power, Bridgeport had three and one-half miles of macadam roads and about one-half mile of block pavement.

The city now has seventy-eight miles of improved streets, the standard of which is so high that it will always be maintained by the public, whose appreciation of the difference in their present condition and the old will not allow the old system to ever again be tolerated. The annual expenditure for the improvement has been from seven to fifteen thousand dollars less than the average cost of the preceding years, and Bridgeport has become one of the most successful and progressive cities in New England in street improvements. It is visited by delegations

from many points of the United States who go to inspect its method of improvement.

For some reason it was found necessary a short time ago to make a change in the street commissioner's office, and Mr. Pierce has been succeeded by Mr. C. A. Grannis. The work that Mr. Pierce has accomplished during his administration is universally approved. His methods, requiring the best work, most permanent results and careful preservation of former improvements, will be strictly adhered to in the future.

TESTIMONY OF MUNICIPAL OFFICERS ON STREET PAVING.

The *Tacoma Ledger* sent inquiries to the public works departments of a number of cities regarding the kinds of pavements they were having constructed, the cost of each kind, the kind preferred, and why it was preferred. The information brought out from some of the cities is as follows:

L. W. Rundlett, City Engineer, St. Paul.—The following data in regard to pavements is submitted in accordance with your request:

Cedar blocks on plank cost $1.10 per square yard; cedar blocks on concrete cost $1.50 per square yard; pine blocks cost about 20 cents per yard more than cedar; asphalt can probably be laid cheaper than the last laid in this city at $2.75 per square yard, five years ago.

The above are the popular pavements, evidently. Block pavement on concrete seems to be the probability for some time to come, the cedar being used, except on the steeper grades, where pine is more appropriate. Trinidad asphalt is desirable for the well-to-do residence districts and is bound to grow in public favor.

A. W. Cooke, Chief Engineer, Chicago.—We have five classes of pavements, namely: Cedar blocks, sheet asphalt, brick, macadam and granite blocks. Cost of cedar blocks on two-inch plank foundation, $1 per square yard; vitrified bricks, on six inches of broken stone, $1.80 per square yard; granite blocks on six inches macadam foundation, $2.90 per square yard; sheet asphalt on six inches of concrete foundation, $2.90 per square yard; twelve-inch macadam, $1 per square yard. All of the foundations for the above pavements are artificial, consisting of earth foundation from one to six feet deep, to bring the street to the sub-grade, and upon this foundation the street is constructed. Sixty-six per cent. of our pavements are made of cedar blocks. For the business streets granite blocks are in favor; residence streets, sheet asphalt is used in many cases where property owners can afford the cost; otherwise cedar predominates. The recent annexed portions of the city, namely Hyde Park, Town of Lake and Lake View, macadam is almost exclusively used.

E. M. Schmengel, Sec'y B. of P. W., Milwaukee.—We are using three kinds of pavements in this city, viz: Cedar blocks, costing $1.25 per yard; granite blocks, costing $2.40 per yard; asphalt pavement, costing $3 per yard. We consider asphalt pavement the best, although many object to it on account of its cost. Granite blocks are used on our heavily traveled business streets and is the only pavement that can stand extraordinary wear and tear. When laid on a concrete foundation, it costs about $3.25 per square yard. For residence streets, where the property owners can stand the expense, asphalt is the most desirable, but most of the paved streets of the city are of cedar blocks.

E. M. Bigelow, Director of Department Public Works, Pittsburgh.—The best paving material that we are using at present time is granite. In fact it is the best all over the world, and it costs about $3 per square yard. We are compelled, owing to the nature of our natural foundation, which is mud, to use an artificial one, made from either gravel or broken stone and gravel combined. We have paved no wooden block pavements since 1876. We have paved a number of streets with asphalt, costing from $2.50 to $3 per square yard, according to the depth of the foundation.

Arthur C. Harris, President Board Public Works, Denver.—The citizens of Denver have well defined opinions on the question of paving and experience has shown their wisdom. First, we will have nothing but asphalt on the retail business streets, and on streets on which our large office buildings are situated. It is considered a necessary luxury, but we are willing to pay for the comforts of life when it is demonstrated that they do not cost too much. We know that asphalt is the most noiseless pavement now known, and that feature alone is most important in the preservation of health and the quieting of nerves strained to their full capacity in the ordinary affairs of life. As a sanitary pavement it has no equal, as there is no possibility of any seepage passing through its surface. The saving in the wear and tear of horses and vehicles is enormous. Large transfer companies here tell privately that they can on asphalt do the same business as before with half the number of horses, and those they use are easily kept in condition. Trinidad sheet asphalt costs us now $2.98 per square yard on a 6 inch concrete base, with a five year repair guarantee. For streets where the heavy traffic is done Colorado red sand stone is used, and it makes a magnificent pavement when laid on a 6 inch concrete base, the blocks 8 to 12x 4½ to 5½ inches, 6 inches high. We pour hot sand and tar between the blocks so the pavement is smooth and almost uniformly impervious to seepage. The last we laid cost us $3.13 per square yard, and ought to be good for from 15 to 25 years, and is guaranteed for five years. Denver is unchangeably committed to the use of a concrete base six inches thick on all business streets, and all our curbs are laid with six inches of concrete under and at the back, so that the curb stones never move, and are always in an absolutely straight line. The concrete also prevents street dirt seeping between the joints and soaking into the soil and basements. There is no question but that a concrete base should never be omitted. The first cost is not to be considered for a moment when compared with the great advantages to be derived. We have never used wood blocks and probably never will. For economy alone sandstone blocks are the cheapest for paving, but we won't have it at any price on our retail business streets for the reason already given. Asphalt will last from five to ten years, according to the traffic on the streets. Sand stone is considered good to last fifteen to twenty-five years.

SPECIFICATIONS FOR STEEL FOR BRIDGEWORK.

Mr. George H. Thomson has recently issued a sheet of standard specifications for structural steel. The specifications for raw materials used in the manufacture of steel for ingots provide that all raw material used in the manufacture of

steel ingots shall be chemically within the Bessemer limit of the following proportions: Sulphur, 0.05%; phosphorus, 0.10%; copper, 0.40%. The usual provisions are added as to the rights of inspectors.

The specifications for the manufacture of ingots make the following requirements: 1. All ingots must be cast from steel melted in an acid-lined open-hearth furnace; 2. The ingots shall be subject to the acceptance or rejection of the inspector of ingots; 3. No single ingot or casting shall (in order to avoid extreme segregation) exceed 15,000 pounds in weight; 4. All ingots must be bottom cast; 5. No ingot shall be disturbed or removed from the position in which it is cast until it is sufficiently solidified to obviate "bleeding"; 6. All ingots shall be duly marked for identification, and a complete and correct report of each cast, giving the number, size and weight of each ingot, shall be furnished by the contractor to the inspector of ingots within five hours after the cast is made; and the contractor shall furnish said inspector such further data as he may require to assist him in keeping the record of the identity of ingots; 7. The inspector of ingots shall have free access at all times to the works where the ingots are cast.

The specifications for rolled steel make the following requirements: 1. Steel shall be rolled only from identified and duly accepted ingots. 2. Finished rolled steel shall show under analysis not more than the following proportions: Phosphorus, 0.08%; sulphur, 0.04%; manganese, 0.45%; copper, 0.20%. 3. All finished rolled steel shall be straight, well finished in the rolling, full to dimensions and free from laminations, buckles, surface, edge or other defects. 4. All finished rolled steel shall possess certain definite physical properties which shall be determined by the inspector of rolled steel from such test pieces (to be prepared by the contractor) as said inspector shall determine as follows: Ultimate tensile strength plates and shapes, between 58,000 and 65,000 pounds; ultimate tensile strength rivet red, between 50,000 and 54,000 pounds; elastic limit plates and shapes, not less than 38,000 pounds; the elongation in plates and shapes under 36 inches wide must be 26% in 8-inch lengths; the elongation of plates over 36 inches wide must be 24% in 8-inch lengths; reduction of area plates and shapes, 50%; reduction of rivet rod, 60%. 5. The fractures of test pieces shall be mainly fine grained. 6. Finished rivet rod when heated to a red heat and upset for 3 inches of metal, shall show (upon cutting out) a silky fracture. 7. Strips of finished material cut along the direction of rolling shall withstand cold, bending double upon itself under the hammer without visible cracking. 8. Prepared specimens cut from finished material at random shall show no piping.

THE PAVING QUESTION IN MINNEAPOLIS.

Not long since a meeting was held at the City Hall, in Minneapolis, for the purpose of ascertaining the wants of the property owners on Nicolett avenue regarding a suitable paving material for that thoroughfare. Cedar block was almost unanimously favored, much to the disappointment of the brick and asphalt men. Since this meeting, however, those who so strongly advocated cedar block seemed to have undergone a complete change of mind. Not the least significant

proof of this change is discerned in the action of Mr. Robert Blackwood, who, at the previous meeting, led the fight for the cedar block men, and who is now circulating a petition for asphalt. Quite a number of property owners now favor brick or asphalt, who before voted for cedar block. At a recent meeting one of the brick men had in his possession a petition which represented 960 feet, although he claimed he had just begun the circulation of the paper.

NATIONAL ROAD CONFERENCE.

The New Jersey State Road Improvement Association has called a national road conference at Asbury Park, N. J., July 5 and 6, at the time of the National Editorial Convention. The call is indorsed by the National League for Good Roads, and is commended by the Secretary of Agriculture, through the special agent and engineer in charge of Road Inquiry, Gen. Roy Stone. An exhibition of road-working machinery and practical road construction will be features of the meeting.

COMPLAINT REGARDING THE LETTING OF A CONTRACT.

A letter of complaint has been received regarding the awarding of a contract at Urbana, Ill., last month, notice of the letting of which appeared in the June number of PAVING AND MUNICIPAL ENGINEERING. As advertised, the contract represented about two miles of brick paving and sewering, but when awarded the letter states it comprised but four blocks of paving and was given to the highest bidder. The bids received were as follows: Lindley & Sipes, Urbana, Ill., Urbana brick, $1.44, wood curb, 9 cents; J. W. Fitten, Chicago, best Wabash brick, $1.39, Urbana brick, $1.40, Poston paving block, $1.42, wood curb, 11 cents, sandstone, 35 cents, limestone, 50 cents, resetting old curb, 20 cents; John Cherry, Jacksonville, Ill., Urbana brick, $1.40, Wabash brick, $1.48; Henry Ammann, Decatur, Ill., Decatur brick, $1.48. After the bids were opened and read, and a few words passed, it is stated that the work was awarded, without assigning a reason for giving it to the highest bidder.

ROCK ASPHALT TO BE TRIED IN CINCINNATI.

Mr. W. H. Delano, of Paris, appeared before the Cincinnati board of public works recently in the interest of the Compagnie Generale des Asphalts de France, which will endeavor to introduce its material at Cincinnati. Mr. S. J. Osborne, Jr., will represent Mr. Delano at Cincinnati and will ask permission to lay a specimen of rock asphalt pavement in Cincinnati in front of the City Hall on Central avenue to show the merits of the material. Mr. Delano said in Cincinnati that the rock asphalt could be brought from Marseilles to New York at a cost of fifty cents a ton.

FILTRATION OF WATER.

In statistics showing the value of the process of sand filtration of water, Dr. C. W. Chancellor, United States consul at Havre, France, says:

"To have this method of filtration carried out to the best advantage, there ought to be along with it povision for the maximum storage of the water, and the process of storage should be as slow as possible."

W. Kuemmel, the renowned engineer of Altona, Germany, gives some of the principles of the Im-

perial Board of Health in Berlin for preventing the infection of water by cholera germs, which are as follows:

First. Care should be taken that the source whence the water is derived is protected against pollution by human dejections.

Second. Sand filters do not deliver the water totally free from microbes; they restrain only a certain number of them, including the microbes of cholera; therefore sand filters should never be overworked.

Third. The velocity of filtration ought not to exceed four inches per hour.

Fourth. If the quantity of water consumed in the town surpasses the quantity that can be delivered by the existing filters at the required velocity, the water-works have to remedy the defect, either by reducing the consumption or by building new filters.

Fifth. The stratum of filtering sand should never be less than twelve inches thick.

Sixth. When a filter has been cleaned or filled up with new sand it is necessary to waste the first filtered water, with its high number of germs.

Seventh. The effect of filtration must be daily controlled by bacteriological tests of each filter. If the bacteriologist finds suddenly a great number of germs, or unusual species of microbes in the filtered water, such water should not be used at all.

Eighth. If these principles are carefully followed, the danger of microbes of cholera passing through the filtering sand stratum is exceedingly small, as has recently been proven by the Altona water-works, as compared with those of Hamburg.

It is claimed that during the cholera epidemic at Hamburg, those who drank the filtered river water escaped the contagion, but those who drank other than the filtered river water became victims of the disease, thus proving that the water disseminated the disease.

LEGAL DECISIONS.

(Reported specially for PAVING AND MUNICIPAL ENGINEERING.)

Limit to Right of Street Railroads to Use of Streets.—Street railroads have the paramount but not exclusive right to the use of their tracks, and are liable for injuries caused by their negligence to persons on the track. Heffran *v.* Brooklyn Heights R. Co., City Ct. of Brooklyn, 28 N. Y. Supp. 518.

Compensation for Taking Railroad Land for Street.—The measure of compensation for railroad land taken by a city for a street is the decrease in its value for railroad use caused by its use as a street, without reference to such expenditures as the railroad company may be obliged to make in complying with the police regulation of the city in regard to street crossings. The fact that the railroad company owns the land in fee makes no difference in the measure of compensation, since a railroad company has no right to any land for other than railroad purposes. C., B. & Q. R. R. *v.* City of Chicago, Sup. Ct. of Ill., 37 N. E. Rep. 78.

Liability for Negligence of Contractor.—A company which obtains leave to dig up streets and lay its pipes along them is liable for personal injuries caused by the defective filling of a trench, even though the work was being done by and under the exclusive control of another, who had contracted to do the work for the company. Colgrove *v.* Smith, Sup. Ct. of Cal., 36 Pac. Rep. 411.

Liability of City for Water-works Bonds.—A city charter authorized the county to buy or build and conduct water-works, and to that end to issue and sell bonds to a certain amount whereby the city should be deemed to promise to pay to bearer the sum named, with interest; to establish and collect water rates, whose proceeds should be kept as a separate fund, and only used for expenses and improvements on the works and interest on the bonds, all the surplus to go to a sinking fund to pay the principal when due. The sinking fund clause having no express provision to the contrary the city was generally and primarily liable for the payment of such bonds, and resident taxpayers had the right to sue to enjoin their improper issue. Though the purchase or erection of water-works be a matter within the discretion of the city council, yet equity will, at the suit of taxpayers, restrain their purchase for $28,000 of water-works worth only $10,000, and inadequate and unsuited to the purpose. Avery *v.* Job, Sup. Ct. of Ore., 36 Pac. Rep. 207.

Sufficiency in Presentation of Claim for Damages.—Under a city charter providing that no claim against the city for damages caused by negligence shall be received for audit unless made out in detail, specifying "when, where and how occasioned," a claim is sufficient where it states that, on a certain evening, claimant's buggy was overturned by coming in contact with a pile of dirt in the middle of a street at a point about one-third of a mile east of a certain railroad; that claimant was thrown to the ground and rendered unconscious by the fall; that the exposure during unconsciousness caused a severe sickness; that his buggy and harness were broken, and that he claims $200 for personal injuries and $20 for damages to his buggy and harness.

The claim need not aver negligence on the part of the city, as the charter does not require such allegation. Werner *v.* City of Rochester. Sup. Ct., Gen'l Term, Fifth Dep't, 28 N. Y. Supp. Rep. 226.

PERSONALS.

Mr. F. R. Lockling was, June 4, reappointed city engineer and sewer commissioner, at Hannibal, Mo.

Mr. A. W. Smith was, May 28, re-elected city civil engineer at Kokomo, Ind., for a term of four years.

Mr. J. B. Weddell, Mansfield, Ohio, is the engineer in charge of the proposed street paving, at Ashland, Ohio.

Messrs. John A. Price and C. E. Groce, were recently elected members of the board of public works at Columbus, Ohio.

Messrs. M. Borgo, J. F. D. Smith and J. B. Curtis have been elected sewer commissioners by the common council, at Red Jacket, Mich.

Mr. George Scharf, general western manager of the Warren-Scharf Asphalt Co., at Cincinnati, has severed his connection with that company, and is now superintendent of the Fruin-Bambrick Construction Company, at St. Louis.

LETTERS FOR THE PUBLIC.

OPINIONS OF CHEMISTS ON THE QUALITIES OF ASPHALTS.

To the Editor of Paving and Municipal Engineering:

As one of your readers allow me to thank you for the impartial manner in which you handle municipal matters.

A good deal of discussion has been going on as to asphalts and their relative merits, and few really understand that it is impossible to tell, with any degree of accuracy, the value of any new variety until it has stood the test of time.

Messrs. Von Schulz & Low, the most prominent and reliable chemists and assayers of this city, acted as chemists for the city at several occasions in testing asphalts, and have done considerable work for the Blake Asphalt Co. and have given the subject a great deal of study.

Prof. Regis Chanvenet is president of the Colorado State School of Mines, and a chemist of national prominence in all matters pertaining to minerals.

The board of public works of this city, through its president, Mr. A. C. Harris, addressed a letter of engineering to each of the above, *i. e.*, Von Schulz & Low and Prof. Chanvenet, propounding a series of questions as to asphalts.

I enclose you herewith the questions and the replies, which, I believe, will be of great interest to the readers of your magazine. We hear from Prof. De Smedt, Capt. Torrey, Mr. Howard and others of equal ability, but all interested financially in one asphalt or another, which must prejudice their articles more or less. It is very seldom we hear from so-called asphalt experts, who are not interested parties in some particular kind of asphalt. This is not strange as the industry is comparatively new and it is hard to find a disinterested party who has any valuable knowledge of asphalts. The value of Messrs. Von Schulz & Low's opinion is emphasized when you take into consideration the fact that the Blake Co. handle a new variety of California asphalt, and he would naturally be prejudiced in their favor, if at all. *M.*

The questions referred to in the foregoing letter as having been addressed by Mr. Harris to the chemists are as follows:

"A discussion has been going on in this city which the citizens are largely interested in, in regard to asphalt paving.

"It is claimed on one hand that asphalt is asphalt, no matter where it is found, and the only difference in asphalts is in the amount of bitumen which they contain. As a well known and practical chemist in this city, I would thank you to answer the following questions, and send me a bill for your expert opinion.

"1. Does the percentage of bitumen determine the value of an asphalt for paving purposes?

"2. May or may not an asphalt contain a very large percentage of bitumen and still be worthless for paving purposes?

"3. Might or might not an asphalt, which, in its natural state, is good for paving purposes, be so

destroyed by heat that it is practically worthless for paving purposes, and still the material after subjection to heat be asphalt?

"4. Might or might not two asphalts contain the same amount of bitumen, and one be so unstable that it will not stand exposure to the sun, and the other be comparatively permanent?

"5. Is it possible that one asphalt might contain twice as much bitumen as another and still be far inferior for street construction to the one containing a less quantity?

"6. Is there any real system by which a chemist can tell to a certainty, by analysis, whether a given asphalt which has never been tried will make as good, permanent and durable a pavement as another which has proved a success?

"7. Are there or are there not qualities required of an asphalt for paving purposes which make it impossible for a chemist who has not made the subject a special study to state for a certainty whether a given untried asphalt will make as good a pavement as another asphalt which has proved a success?

"8. What is the real test of standard or quality which will give the value of an asphalt for paving purposes?

"9. Might an asphalt pavement stand for one or two years, and fail from effect of elements in succeeding years; and might two asphalts stand equally for two years and show marked differences in wear in succeeding years?

The answers to these questions by the chemists were as follows:

1st Answer—The percentage of bitumen does not determine the value of an asphalt for paving purposes.

2d Answer—An asphalt might contain a very large percentage of bitumen, and still be comparatively worthless for paving purposes.

3d Answer—An originally good asphalt for paving purposes might be so altered by heat as to be practically worthless, and yet the altered material would still be asphalt in the sense that it could not be distinguished from asphalt, notwithstanding its marked inferiority to the particular asphalt from which it was produced.

4th Answer—Two asphalts might contain the same amounts of bitumen and yet possess entirely different powers of resistance to the destructive action of the elements. One might thus be comparatively permanent and stable, and the other greatly inferior.

5th Answer—As the percentage of bitumen in an asphalt does not determine its value for paving purposes, it is quite possible for one asphalt to contain a much higher percentage than another and yet be decidedly inferior for making a durable pavement.

6th Answer—There is no system of chemical analysis that will determine for a certainty that a given untried sample of asphalt will make, in every way, as good a pavement as another asphalt which has proved a success.

7th Answer—The requirements of an asphalt for paving purposes are of such a peculiar nature that it would be impossible for a chemist who had not made the subject a special study to state with certainty from the results of analysis, whether or not a given sample would make as good a pavement as an asphalt which had proved a success.

8th Answer—The real and final test of the quality of an asphalt for paving purposes is actual trial for a proper length of time. Proper chemical and physical tests of a new variety of asphalt may strongly

indicate its probable value as a paving material, but these tests, though of great assistance in forming an opinion, really only show the advisability of submitting the asphalt to the final and infallible test of actual trial.

9th Answer—A test of one or two years under any condition demonstrates only that that particular asphalt pavement is good for that length of time under those conditions, and does not demonstrate how much longer it will last under the same conditions, or whether it will last as long under other or more unfavorable conditions. Two asphalt pavements might endure equally well for a given short time, and yet show decided difference under a long trial.

Having thus briefly answered the questions asked, it may, perhaps, be well to give some explanation of the subject, in order to indicate the reasons for the opinions expressed. First of all, it may be stated that asphalt is not a chemical compound or mineral of fixed and invariable composition. According to Dana it is a mixture of hydrocarbons, and the asphalts of different localities have various compositions. Mineralogically bitumen is simply another name for asphalt or asphaltum. In paving parlance, however, bitumen has come to mean only the pure portion, so to speak, of the asphalt, the latter term being applied to the entire mixture of earthy and other impurities with the true bitumen. This view of bitumen having evidently been taken in the questions asked, it was similarly considered in the replies. It is to be understood, then, that asphalt is an impure bitumen, and that bitumen is the pure article considered by Dana in his Mineralogy. But, as before stated, bitumen has no fixed composition or combination of qualities. Its nature and physical properties are as various as the localities where it is found. It can be no more strictly defined than coal. It is simply a mixture of various hydrocarbons and may be either a solid or a liquid. Two bitumens of precisely similar percentage composition may have widely different properties, so that while one would furnish a most excellent paving material the other would be practically worthless. Such instances of substances of entirely dissimilar nature having the same percentage composition abound in chemistry. Charcoal, the diamond, and plumbago, or black lead, may be mentioned as a familiar example. Light naphtha or gasoline and solid paraffine is another. It takes more than an ordinary chemical analysis to distinguish between such substances. Evidently, then, the mere percentage of bitumen in an asphalt would not determine its value for paving purposes, for this bitumen might have a consistency varying anywhere from a non-cohesive liquid to a brittle, worthless solid. By the action of the elements all asphalts undergo change. This change is due to oxidation, volatilization and other molecular disruption, and tends to produce greater solidification or apparent drying, and the asphalt may pass through all the stages of brittleness to final crumbling or disintegration. In all these stages the substance is still asphalt, although at many points it is evidently worthless as a paving material. While these changes are slow in nature, some of them may be greatly hastened by the application of heat, as in incautious or unskillful refining, so as to greatly injure an originally good asphalt. It is evident, also, that an asphalt

may be so far gone in the process of natural decay that, while it may serve to make what appears to be an excellent pavement, the life of such a pavement must necessarily be comparatively short.

Having thus shown how much depends upon the quality or nature of the bitumen in an asphalt rather than upon its mere percentage, it becomes important to know to what extent the chemist can distinguish this valuable quality, and so prevent disastrous mistakes in pavement work. It may be answered that a chemist who has made a special study of the subject can, by proper chemical analysis, aided by certain physical tests, point out what is probably good or worth trying in the case of new varieties, but it is impossible for him to state for a certainty that a particular new variety will be fully equal in every essential respect to some standard asphalt that has proved a success. Having learned by experience the chemical and physical differences between good and bad samples of any particular asphalt, the chemist may thereafter afford valuable assistance in the use of that asphalt.

In view of the foregoing facts it would seem that the extensive use, for paving purposes, of any variety of asphalt that has not previously been proven a success by the test of actual trial for a sufficient length of time, under sufficiently adverse conditions, is in the nature of a rather hazardous experiment.

Trusting that the above answers and explanations will prove clear and satisfactory, we will add that they are given without prejudice and according to our best knowledge of the subject.

Von Schulz & Low,
By Albert H. Low.

Allow me to first say that a few of the questions are such as can not be answered categorically, *i. e.*, that a simple "yes" or "no" might be misleading. As to the general drift of the questions and the answers, I am clear enough.

1st Answer—No. Bitumen can not be held to mean the ordinary (I might say universal) sense of proximate analysis, a substance identical in all its physical properties as well as in its analysis.

2d Answer—I can not answer this quite positively. I can answer a very similar question, probably serving the purposes of the inquiry as well, by saying that an asphalt showing a less percentage of bitumen by analysis than another article, may be better in the practical test than the one containing the greater amount.

3d Answer—So far as analysis is concerned, it might. There are cases in which analysis as used to compare two substances, fails to distinguish between them, yet the substances are quite unlike in their physical characteristics. In this connection it may be remarked that natural heat has often the effect of changing the physical character of a body, without materially altering its composition.

4th Answer. This is a question of special experience. As before, I will give an answer to the main idea, though not the exact wording of the question. "Two asphalts of the same analysis may show very different permanence."

5th Answer—I think it quite *possible*. I consider it *certain* that mere percentage does not determine quality as to wear or laying qualities.

6th Answer—I know of no such method. Of course, any person sufficiently skilled in manipulation can try practical experiments on commercial substances. But so far as analysis is concerned, I do not

hesitate to say that I would not venture, on examination of an asphalt, to pronounce upon its value as a paving material. In fact, I have several times refused flatly to make an analysis of asphalt, because the party bringing same demanded in addition to the analysis proper a certificate of its *fitness for paving*, which I have always insisted I could not give, as deducted from the analysis.

7th Answer—Certainly there are such qualities. The same statement as has already been made, viz: that there are physical properties which analysis does not detect, applies here.

8th Answer—A practical test of the same. By this is not meant that nothing whatever can be ascertained by examination, for frequent analysis may determine the bad quality of an article due to impurities. But with regard to certain commercial articles (asphalt being one of them) it may be safely said that actual trial only can give a final answer as to durability and other paving qualities.

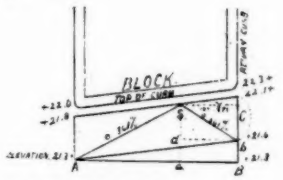
9th Answer—I have seen both of these phenomena (in St. Louis) but I am not prepared to assert that all of the difference came from the quality of the asphalt, *i. e.*, it may have been due in a greater or less degree to the manner of laying down the pavement.

Regis Chauvenet.

MR. LOCKLING'S FORMULA.

To the Editor of Paving and Municipal Engineering:

I send you my formula for finding the distance x to summit, S, in problem published in PAVING AND MUNICIPAL ENGINEERING, page 230, of May, 1894:



Given AB=300 feet=a.
+21.6−21.3=0.3=b.
+22.1−21.6=.05=c.
$\frac{b}{a}$=R=0.001 per foot.

To find the distance x to summit S.
Statement: b+2c−2Rx : a :: c−Rx : x.
(1) $bx+2cx-2Rx^2=ac-aRx$.
(2) $(b+2c+aR)x-2Rx^2=ac$.

(3) $x^2-\left(\frac{b+2c+aR}{2R}\right)x=-\frac{ac}{2R}$.

(4) $x^2-\left(\frac{b+2c+aR}{2R}\right)x+\left(\frac{b+2c+aR}{4R}\right)^2=-\frac{ac}{2R}+\left(\frac{b+2c+aR}{4R}\right)^2$

(5) $x+\left(\frac{b+2c+aR}{4R}\right)=\sqrt{-\frac{ac}{2R}+\left(\frac{b+2c+aR}{4R}\right)^2}$ Extract $\surd$ in (4)

(6) $x=\pm\sqrt{-\frac{ac}{2R}+\left(\frac{b+2c+aR}{4R}\right)^2}-\left(\frac{b+2c+aR}{4R}\right)=108.453$ feet.

Again triangle SAa is similar to triangle Sed.
But Sa=c+(300−108.453)R=0.691547
and Sd=Sa−b=0.691547−0.3=0.391547

or rate per cent. from summit=$\frac{Sa}{a-x}=\frac{Sd}{x}=\frac{0.691547}{1.91547}=\frac{0.391547}{1.08547}=0.361\%$.

I am in hopes some one will furnish a shorter solution.

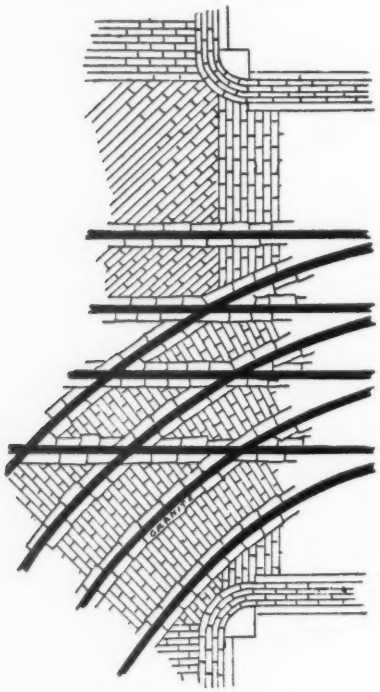
F. R. Lockling,
C. E. and S. Com'r.
Hannibal, Mo., May 31.

SELECTIONS FROM THE PRESS.

BRICK PAVING AT LOUISVILLE.

The city council of Louisville, Ky., has recently passed a complete series of ordinances specifying the manner in which all paving shall be laid, and the quality thereof. As regards brick paving, the ordinance is complete in all details.

It provides that the street surface shall be worked to grade, and that the crown of the subgrade shall be twelve inches below the top of the



curbing when set to grade. After being thoroughly rolled and cleaned and the material approved, a six-inch bed of hydraulic cement concrete shall be laid. The formula for the cement is: One measure of cement and two of clean, sharp sand, thoroughly mixed dry, and then made into mortar with the least possible amount of water; broken stone or hard brick cleaned, drenched with water, but containing no loose water in the heap, to be incorporated with the mortar so as to give a surplus of mortar. This mixture is to be spread and rammed. On the foundation thus prepared, a bed of clean, sharp sand shall be spread two inches deep, and upon this bed the paving brick is to be laid, on edge, at right angles with the street, except at street intersections, where the board of public works may make special orders. Brick must be laid as compactly together as possible, and all joints are broken by a lap of at least two inches. The brick must be hard burned, for paving especially, of uniform size and free from flaws. Nothing less than a half brick may be used to break joints. The brick must be burned throughout to vitrification. When the brick has been laid for a distance of sixty feet, the first fifty feet must be covered with clean, sharp, dry sand, which must be swept in and the whole pavement rolled or rammed to the true section. After the rolling and ramming is completed, the joints shall be filled with paving cement, obtained from the residuum of distillation of asphalt or coal tar. Then the whole shall be covered with half an inch of sand.

Footway crossings are built three inches higher than the street. When a street railway track is laid in the street, the rails, ties and stringers

shall be put in place by the company before the paving is laid, or if afterwards at the expense of the company, as shown in the engravings. Street intersections and curves shall be laid as shown in the plan. A granite liner between the brick and the rail is provided. The space between the track and directly outside is to be filled with concrete.—*Street Railway Review.*

The recently organized Bermudez Company, in the city of Indianapolis, is to have a new asphalt plant. Four or five men only will be required to operate it. The manipulation of the plant will be as nearly automatic as possible.

A series of molds for brick have been devised by Mr. H. C. Bruner, of Pontiac, Ill., that will be made in such shape that they can be used with any pavement in paving to any type of rail. It can be made to fit a girder, a T, or center bearing rail. By the use of this brick filler it is thought that the expense of wood fillers along street railway tracks will be lessened.

John G. Tait & Company, 100 Maiden Lane, New York City, has taken the agency for the sale of tools, heaters, etc., used by asphalt and concrete paving contractors. The list of paving tools now being handled by this company includes asphalt kettles, wrought iron stirrers for mixing the asphalt in kettles, buckets for carrying asphalt, spatulas and floats for smoothing the surface.

A very complete and practical method for keeping systematic records of work is put forward by Howard Challen, No. 10 Spruce street, New York, in his labor saving records. His engineer's log book would seem an invaluable aid to a steam engineer, for it requires not only a little time each day to keep a record of the workings of an engine but by referring to such records and making comparison with former experiences, much information is available for further improvement.

The new plant for the Laidlaw-Dunn-Gordon Pump Company, on which Mr. E. F. Layman, of Cincinnati, is engaged, is situated at Tweedvale, seven miles north of Cincinnati. The main building will be 660 feet long and 114 feet wide. The foundry will be 300 feet long and 200 feet wide. In addition to these will be blacksmith shops, and a foundry and pattern warehouse. The buildings will be of steel with slate roof and walls filled in with stock brick, and will occupy about twelve acres of land. The plant will also comprise a complete water supply and sewerage system.

The Decatur Leader Manufacturing Company, Decatur, Ill., issued in June a book of testimonials from parties who had used their machinery for some time, and were able, therefore, to give the result of time and trial. At present the Decatur Manufacturing Company's line consists of five sizes of brick machines, four sizes of tile machines, six sizes of crushers, five sizes of pug-mills, all sizes of clay elevators, all sizes of tile elevators, two sizes of freight elevators, eight different cutting tables, trucks, barrows, cars, presses, wire, engines and boilers, shafting, pulleys, hangers and belting.

IMPROVEMENT AND CONTRACTING NEWS

PAVING.

The paving of Main and River streets at Janesville, Wis., will be completed by July 4.

From twelve to fifteen miles of streets in Kansas City, Mo., are reported as sadly in need of repairing.

The Virginia Paving Company has finished its contract at Knoxville, Tenn. The company claims that this is the largest piece of work that has been done in the South for three years.

An injunction was recently petitioned at Ludwich, Pa., on the complaint that the special election, held May 3, to increase the borough indebtedness under the act of April 20, 1874, was illegal.

The paving of Grand avenue from Ninth street to Thirteenth street was recently accepted from the Barber Asphalt Paving Company, at Kansas City, Mo. The cost of the work was $33,853.49.

The new pavement on East Broadway, at Toledo, Ohio, has been accepted by the city engineer and council, but dissatisfaction is expressed by the property owners along the street, who claim that it is defective.

A number of the city officials of Hartford, Conn., have visited various cities recently for the purpose of examining the different methods of street paving. They are especially desirous of knowing more about block asphalt paving.

Under the direction of Superintendent Stowers, the repairs and street improvements made at Hyde Park, Mass., this summer, have proven highly satisfactory. Particularly is the improvement of the upper end of Beacon street noted.

By a recent decision of the court, a street law, passed in 1891 for Philadelphia exclusively, becomes applicable to Pittsburg and other cities of the commonwealth. The law reads: "In all cases of assessment of damages for the opening or widening of any street in any city in this commonwealth the award of damages, if any, shall include all damages due to the grade at which said street is to be opened or widened, and the plan attached to the report of the viewers awarding damages shall have a profile showing the existing grade."

CONTEMPLATED WORK.

Street paving is contemplated at Adrian, Mich.

Street paving is contemplated at Waukesha, Wis.

The necessity of more street paving is being urged at Lowell, Mass.

The city of Cardington, O., recently voted in favor of street paving.

Petitions have been made at Bradford, Pa., for paving a number of streets.

The city of Eau Claire, Wis., contemplates the construction of brick pavements.

Broadway, between Columbia and Fayette streets, Utica, N. Y., is to be paved.

A movement has been made at Chester, Pa., for paving Market street with sheet asphaltum.

The city council at Piqua, O., decided, about June 1, that that city should have paved streets.

The county commissioners, at Denver, Colo., have been petitioned to pave Court place with brick.

An ordinance has been passed at Wausau, Wis., which provides for paving Scott street with cedar blocks.

The paving of Washington street, from Main to Marshall, is again being agitated at Poughkeepsie, N. Y.

The citizens of Watertown, N. Y., are anxious to improve the city by the construction of pavements.

Vitrified brick is favored by the property-owners for the proposed paving of Front street, at Seattle, Wash.

The city council of Lansing, Mich., passed a recent resolution ordering about 5,000 square yards of brick paving.

The city council at Taunton, Mass., has been petitioned for an asphaltic pavement on City Square and Court streets.

The city council of Zanesville, Ohio, has declared it necessary to pave with vitrified paving brick, Second street and Linden avenue.

A block of Sixteenth street, from Third avenue south, and a block of Fifth avenue, from Eighteenth street west, is to be paved at Rock Island, Ill.

The property owners on Fourth street, at Williamsport, Pa., are said to be willing to pay the full cost for a new pavement in front of their homes on that street.

The city council at Bozeman, Mont., has decided to pave Main street for a distance of sixteen blocks, with Telford macadam. The estimated cost is more than $30,000.

Plans and specifications are being made by the city engineer, at Great Falls, Mont., for paving Central avenue from Sixth street to Park drive with cedar or fir blocks.

The public improvement committee of the common council, at Rochester, N. Y., voted to report favorably on the paving of Exchange street, from the Four Corners to the Canal bridge.

The city council at Aurora, Ill., has passed an ordinance providing for the paving of Downer Place with cedar blocks from the west side of Lake street west to the C., B. & Q. railroad tracks.

The city council at Youngstown, O., has declared it necessary to pave Wick avenue with asphalt or brick, or asphalt block on a concrete base, or to surface over the present brick pavement with asphalt.

Three resolutions recently introduced at a meeting of the council at Houston, Tex., will give that city, if acted upon, a complete belt of paved streets several miles in length and embracing about one-half of the territory of the south side.

The property owners on Washington street, between Ludlow and Main streets, Dayton, O., recently petitioned that the street be paved with brick. A similar petition was presented by the property owners on Franklin street, between Main and Perry.

The calls for street improvements under the board of survey laws, prompted Mayor Matthews, of Boston, to recommend the passage of an order authorizing the borrowing of $1,000,000 to be expended for street and sewer construction, under these laws. The order was passed.

A petition has been filed with the city clerk at Kansas City, Mo., asking the council to pave James street, from Central avenue to the Kaw river, with vitrified brick. Another petition has been circulated, also, asking for an asphaltic pavement on the same thoroughfare. This street was paved with cedar blocks about eight years ago.

The Cincinnati *Commercial Gazette* says: "When Bruce avenue was paved with Kentucky sandstone, which by some was supposed to be asphalt, the property owners bound themselves to keep it in repair, without expense to the city, the contract having been a private one, and if the new paving proved to be poor, to replace it with asphalt. The engineer reported that the street is in a miserable condition, and almost unfit for travel. And effort will now be made to compel the property owners to improve it with asphalt. The cost will be about $10,000."

Representatives of some of the business firms at Minneapolis recently called at the city hall to ask that Twenty-fourth avenue N, from Washington avenue to the Northern Pacific tracks, be paved. These business firms have been endeavoring for years to induce the city council to order this paving, and it is probable that their efforts will prove successful this time.

Street paving resolutions have been passed at Kansas City, Mo., providing for paving with Trinidad lake asphalt, two inches, on a foundation of five inches of hydraulic cement concrete, and on this a binder of one and one-half inches of bituminous concrete, the following: Eleventh street, from Grand avenue to Cherry street; Forest avenue, from Independence avenue to Twelfth street.

CONTRACTS TO BE LET.

The contract for brick pavements will be let at Covington, Ky., during July.

S. J. Hannagan, Lafayette, Ind., will receive bids up to July 9 for improving Nineteenth street.

Bids will be received by L. Swineheart, Goshen, Ind., until July 3, for paving sundry alleys with cobble-stones.

Bids will soon be invited by F. C. H. Benson, city clerk at Excelsior Springs, Mo., for paving Main street with stone.

Sealed proposals will be received at the office of H. L. Weber, city engineer, at Bucyrus, O., until July 17, for the improvement of Spring street.

Sealed proposals are invited by the committee on paving, at Wausau, until July 16, for grading, curbing and paving Washington street with cedar block.

Sealed proposals will be received by Jeremiah Rex, at Tiffin, O., until July 14, for paving Jefferson street with paving brick on a stone and gravel foundation.

Sealed proposals will be received at Lima, O., until July 3, for paving the public square with vitrified paving brick. Address R. H. Gamble, city engineer.

F. C. Wilson, Akron, O., invites bids until July 14, for paving Adolph avenue, between Market and Perkins streets, with brick. A certified check of $200 is required.

Sealed proposals will be received at Columbus, O., until July 10, for the improvement of Wyandotte avenue, from Summit street to C., C., C. & St. L. R. R. Address Henry J. Caren, county auditor.

Sealed proposals will be received at Wooster, O., until July 6, for paving Spruce street, from South Market to East Vine street, with fire-clay or shale brick, or some other suitable brick or block, and setting curb and gutter stones.

Bids are invited by J. M. Hackett, city engineer at Dunkirk, N. Y., until July 3, for grading and paving or macadamizing Central avenue. The work comprises about 3,706 cubic yards of excavation and 8,800 square yards of pavement.

Bids are invited by Howe McGuire, city clerk at Wabash, Ind., until July 9th for the completion of the work for the improvement of East street by macadamizing and graveling the roadway and paving the sidewalks on both sides of the street.

Sealed proposals will be received at the office of Kennedy & Kennedy, at Crawfordsville, Ind., until July 5, for constructing one-third of a mile of gravel road in Union township near the iron bridge over Offel's Creek. P. S. Kennedy, superintendent.

Sealed bids will be received by Michael Kigin, Tipton, Ind., until July 7th, for the construction of a gravel road, known as "Tetersburg and Ekin gravel road No. 8." Specifications will be found at the law office of Beauchamp & Mount. Address, Michael Kigin, Superintendent.

Sealed proposals will be received by W. Ellwood Wynne, Avondale, O., until July 14, for the improvement of the following: Linden avenue, from Reading road to Harvey avenue; Wallace avenue, from Reading road to Washington avenue; Dutton avenue, from Woodward avenue to Ridgeway avenue.

Sealed proposals will be received by the committee on highways at York, Pa., until July 3, for grading and paving four separate squares with asphalt block or vitrified shale brick or block on six-inch concrete foundation. The work comprises, approximately, 15,200 square yards. Address R. C. Boeckel, clerk, care the P. C. Wiest Company, York, Pa.

Sealed bids are invited by the street committee of the common council at Charleston, W. Va., until July 5, for grading and paving with brick Virginia street, from Broad to Morris street; Morris street, from Kanawha to Washington street, and Quarrier street, from Broad to Brooks street; for furnishing paving brick or blocks in quantities of from 700,000 to 1,000,000. All bids and samples of brick or paving blocks to be sent in care of City Engineer W. A. Hogue.

CONTRACTS AWARDED.

The contract for paving Broad street, Waverly, N. Y., was awarded to Costello & Nagle, of Elmira, for $15,935.

The Mack Paving Company, of Pittsburg, was awarded the contract for paving a large number of streets in various sections of the city of Philadelphia, with vitrified brick. The contracts involve an expenditure of nearly $300,000.

The contract for paving State street, Painesville, O., was awarded to Shelby & King, of Painesville, for $17,922 37.

The contract for paving West Main street, Belleville, Ill., was awarded to Abbott & Gamble, of St. Louis, at $14,700.

The Sicilian Asphalt Paving Company of New York, secured the contracts for repairing a number of streets in Pittsburg, Pa.

The bid of the Des Moines Brick Manufacturing Company was the lowest for the paving of Fourteenth street, at Davenport, Ia.

The contracts for paving, at Burlington, Ia., were awarded to Fred Hoppman at the following prices: Division street, $3,492; Leebrick street, $6,752.

Contracts were awarded at Peoria, Ill., June 15, as follows: Paving Main and Adams streets, Henry Bessler, Cedar Rapids, Iowa; paving alleys in blocks 6, 12 and 18, Robert Clarke, Peoria.

The board of public works at Detroit, Mich., recently awarded contracts for brick paving as follows: Russell street, from Gratiot to Adelaide, Thomas Currie, $1.83 per square yard; St. Antoine street, from Jefferson to Gratiot avenues, Thomas Currie, $19,032.05.

The contract for paving Second street, from Adams to Main, at Troy, N. Y., with granite blocks, was awarded to Martin Murray at $66,205. The contract for paving Maple avenue with asphalt was awarded to the Northern New York Asphalt and Paving Company at $3.28 per square yard.

H. A. Collar, Grand Rapids, Mich., writes that during the month of May, contracts for street improvements were as follows: Fountain street, cedar blocks on concrete, $11,351; Valley Street, one-half mile, $594; South College street, 400 feet, $924; Allen street, regravelling, $692; Crosby street, three-fourth mile, $7,362.

The Barber Asphalt Paving Company presented the lowest bids, at St. Louis, Mo., on the following: Labadie, from Marcus to Euclid, $17,587; Park, from Klemm to a point 287 feet east of Vandeventer, $34,214; Old Manchester road, from Tower Grove to Chouteau, $35,503; Taylor, from Easton to St. Louis, $29,212.

C. M. Rickard, city engineer at Springfield, Ill., writes, that contracts were awarded May 24, as follows: Ten thousand yards two course brick pavement on four-inch foundation, John F. Bretz, at $1.16 per square yard; 10,000 yards two course brick pavement on four-inch foundation, N. P. Glann Construction Company, at $1.17; 11,000 lineal feet of sandstone curbing, John Striffler & Company, at 57½ cents.

Harvey Linton, city engineer at Altoona, Pa., writes that on June 16, the contract for paving Ninth street, from Chestnut avenue to Sixteenth avenue, was awarded to Erbeck Brotners, of Homestead, Pa., as follows: 2,571 square yards vitrified paving brick on six-inch concrete foundation, $1.76 per square yard; 533 square yards repressed bevel edged brick on six-inch concrete foundation, $1.85 per square yard.

Contracts for street paving were awarded at Dayton, O., recently, as follows: Washington street, from Main to Ludlow, Hallwood block, Edward Ryan; Ludlow street, from Third to Washington, Trinidad asphalt, Trinidad Asphalt Company; Franklin street, Trinidad asphalt, Warren-Scharf Asphalt Company; Salem street, from River to Prospect, Trinidad asphalt, and the spaces between the rails and driveway track with Hayden block, Warren-Scharf Asphalt Company.

Contracts were awarded by the street and sewer directors, at Wilmington, Del., for $45,000 worth of paving brick as follows: Pine street, 5,316 square yards, 90 cents per yard, Interstate Vitrified Paving Brick Co., Philadelphia; Washington street, 4,924 square yards, $1.13 per yard, Canton Shale Exchange, Canton, O.; Jefferson street, 1,310 square yards, $1.07 per yard, C. Warner Co., Toronto, O.; Sixth street, 911 square yards, $1.05 per yard, J. C. Bolen, Zanesville, O.; Tenth street, 2,792 square yards, 90 cents per yard, Geo. H. McCall Co.; north side of Second street market house, 522 square yards, $1.05 per yard, J. C. Bolen, Zanesville, O.

SEWERS.

The brick work on the mammoth Cedar street sewer, at Muscatine, Ia., is completed.

The proposition to appropriate $25,000 for additional sewers at Glens Falls, N. Y., was voted down.

It will require $267,210 to complete the partly constructed sewerage system at Salt Lake City, Utah. The sewer is of brick and concrete, and is 36,500 feet in length. Its total cost will be $429,000.

From the time that the sewerage system at Summit, N. J., began operation the utmost care and vigilance has been required to maintain its efficiency, and it is feared that unless a very effective plan is adopted soon for flushing the mains the system will be materially affected.

The contract and surety of George S. Good & Co. has been approved at Philadelphia, Pa., for the construction of a main sewer on Indiana avenue. The total cost of the work to be done is not to exceed $27,000. The total cost of the construction of a main sewer on Ontario street, for which James Sullivan has the contract, is not to exceed $75,000.

The work of construction has begun on the Frederick street sewer at Cumberland, Md. According to specifications the sewer will be constructed of brick and will be arched. The inside diameter will be 36 inches and the length will be about 2,500 feet. The walls of the sewer will be nine inches thick all around. Mr. Lawrence G. Hallock has the contract.

CONTEMPLATED WORK.

The sewerage question is being discussed at Dansville, N. Y.

A new sewerage system is contemplated at Santa Monica, Cal.

A system of sewerage is still talked of to some extent, at Eureka, Cal.

An ordinance providing for a general system of sewerage has been passed at Lansing, Ia.

The city council, at Monroe, Wis., has decided upon the plans of the proposed sewerage system.

The citizens at Tyndall, S. D., are discussing the advisability of putting in a system of sewerage.

The council at Cleveland, O., has ordained that sewers be constructed in Marcelline avenue and Brevier street.

J. Alcide Chaussé writes that a competent sanitary engineer will be engaged to report on a general sewerage system for the town of Chatham, Ont.

The city council at Corry, Pa., has passed an ordinance providing for the construction of a sewer in certain portions of Park Place street and Maple avenue.

At a recent meeting of the town council of Niagara Falls, Ont., it was decided to vote, August 6, on a by-law to raise $88,000 for a general system of sewerage.

The board of public works at Denver, Colo., estimates that $318,512 will be required to build the proposed extension, 14,736 feet of the Delgany street sewer.

Ordinances have been passed at Kearny N. J., providing for the construction of sewers in Van Emburgh avenue, from Argyle Place to Elm street, and in Kearny avenue, between Stewart avenue and Laurel avenue.

The board of public works at Niagara Falls, N. Y., has been petitioned for the extension of the present tunnel sewer, eastward to Steadman street, and for the construction of a brick sewer from the New York Central tracks at the north end of the city, south to Pine avenue.

An appropriation of $8,000 is asked at St. Joseph, Mo., for the construction of a main sewer on Sycamore street. The sewer will be, as proposed by the ordinance introduced, a three-ringed brick structure, eight feet in diameter and will be provided with the usual appurtenances.

CONTRACTS TO BE LET.

Bids will be received by G. W. Shearburn, River Forest, Ill., until July 2, for the construction of a main brick sewer in center of Lake street.

Sealed proposals will be received by J. J. McMaken, city clerk at Hamilton, O., until July 3, for building about eleven miles of sewers in sanitary sewer districts 1, 2 and 3, and storm sewer districts 1, 2 and 6. George S. Pierson, consulting engineer, Kalamazoo, Mich.

Sealed proposals will be received until July 6, by B. F. Eason, city clerk at Wooster, O., for the construction of a sewer on Spink street. Length of sewer, 1,994 feet, of 15-inch vitrified fire-clay sewer pipe. Length of laterals, 1,450 feet, of 6-inch vitrified fire-clay sewer pipe.

Sealed proposals will be received until July 6, by B. F. Eason, city clerk at Wooster, O., for the construction of sewers in North Buckeye, North Bever and East Bowman streets. The total length of these sewers will be 5,548 feet and they will be constructed of 12, 15, 18 and 20-inch vitrified fire-clay sewer pipe. The total length of laterals will be 4,075 feet of 6-inch vitrified fire-clay sewer pipe.

Sealed proposals are invited by W. B. Golden, village clerk at Athens, O., until July 2, for the construction of a system of sanitary sewers. The approximate quantities are as follows: 21,110 lineal feet of pipe sewer, 12⅛ inches in diameter; 500 lineal feet house connections; 1,000 lineal feet drain tile; 300 cubic yards rock excavation, together with concrete, brick, lumber, flush tanks and manholes.

Sealed proposals will be received by the city council of Mattoon, Ill., until July 24, for the construction of sewers in drainage district, No. 1, as follows: No. 1 main line—1,727 feet, 24-inch pipe sewer; 730 feet, 21-inch pipe sewer; 766 feet, 18-inch pipe sewer; 766 feet, 15-inch pipe sewer; 631 feet, 12-inch pipe sewer. Branches: E street branch, 350 feet, 10-inch pipe; G street, 370 feet, 10-inch pipe; I street, 370 feet, 12-inch pipe; K street, 370 feet 12-inch pipe; 11 manholes, 9 lampholes. No. 2: 3,200 feet, 12-inch pipe sewer; 4 manholes, 4 lampholes and 13 inlets and connections. See sealed proposals.

CONTRACTS AWARDED.

The city council of Jamestown, N. Dak., awarded to Anton Klaus, of Milwaukee, the contract for sewerage construction for $4,997.84.

The contract for 150 car loads of sewer pipe, for Boone, Ia., was awarded to the John H. Rich Sewer Pipe Works, at Red Wing, Minn.

The contract for the construction of a sewer through Butler street, at Norwalk, Conn., was awarded to Salvator Chariot for $2,771.80.

The contract for a system of sewerage in several streets, at Courtland, N. Y., was awarded to Doe, Nicholson & DeLoy, of Port Huron, Mich.

Contracts were awarded at Grand Rapids, Mich., during May, as follows: Dayton street sewer, one-half mile, $1,744.44; Adams street sewer, between Madison and Paris avenues, $676.

H. Ward, Binghamton, N. Y., writes that contracts have been awarded as follows: 785 feet of pipe sewer, with catch basins, manholes, etc., complete, E. A. Matthews, for $587; 440 feet of pipe sewer, W. H. Conklin, for $337; Frederick street sewer, 820 feet long, John C. Smith, for $740.

Udo Hesse, Saginaw, Mich., writes that contracts were awarded, June 23, for sewer construction as follows: Holland avenue, from Warner street to Genesee avenue, brick 20x30, to John C. Davies, $2,600.25; Mott street, from Weadock avenue to Emily street, 12-inch pipe, to Hildebrand & Eddy, $319.50; Harrison street, from Clinton street to Hancock street, 12 and 15-inch pipe, Hildebrand & Eddy, $743.30; Mason street, from Clinton street to Court street, 12 and 15-inch pipe, Wm. A. Armstrong, $920.95.

Harvey Linton, city engineer at Altoona, Pa., writes, that June 16, the committee on highways and sewers awarded contracts at the following prices: Second district sewer, 4,472 feet long, for excavation and back filling trenches, earth, 70 cents per cubic yard; shale, 95 cents per cubic yard. For the construction of the main sewer, the cost per lineal foot is as follows: 6 ft. x 6 ft. 3 in. brick sewer, with stone invert, $7.88; 5 ft. 9 in. x 6 ft. 1¾ in. brick, with stone block invert, $7.52; 3 ft. 9 in. x 5 ft. 7½ in. brick, with brick invert, $5.79; 2 ft. 10 in. x 4 ft. 3 in. brick, with stone block invert, $5.73; 2 ft. 4 in. x 3 ft. 6 in. brick, with stone block invert, $3.92; 2 ft. 4 in. x 3 ft. 6 in. brick, with brick invert, $2.94; 2 ft. 2 in. x 3 ft. 3 in. brick, with brick invert, $2.75; 2 ft. x 3 ft. brick, with brick invert, $3.00. Fifth avenue branch sewer: 3 ft. 5 in. x 5 ft. 1½ in. brick, with brick invert, $5.93; 2 ft. 11 in. x 4 ft. 4½ in. brick, with stone block invert, $6.41; 2 ft. 8 in. x 4 ft. brick, with stone block invert, $3.71; 2 ft. 4 in. x 3 ft. 6 in. brick, with stone block invert, $3.23; 24-inch terra cotta pipe, $1.00; manholes complete, $35.00; rubber masonry, $7.00 per cubic yard; concrete, $6.50 per cubic yard. The sewer is calculated to carry the flow from a two-inch per hour rainfall.

WATER-WORKS.

A company has been formed at Sturgeon Bay, Wis., to put in a water-works system.

A plan for a water-works system has been adopted by the board of water commissioners at Troy, N. Y.

The water-works system has been completed at Plain City, O., at a cost of $10,000. Thomas H. Botham, of Winona, Minn., had the contract.

Messrs. G. W. Phillips and C. E. Chittenden, of Scranton, Pa., have made a proposition to the village trustees of Dansville, N. Y., in which they offer to purchase the present water plant and supply the town with water.

CONTEMPLATED WORKS.

An appropriation of $4,000,000 is asked for increasing the water supply at Philadelphia.

The citizens of Virden, Ill., have subscribed $1,600 of the $2,000 required for the proposed water plant.

The city commissioners at Key West, Fla., have accepted an offer for the sale of the $100,000 water-works bonds.

C. J. Ducomb, city clerk at Ashland, O., writes, that a vote will be taken July 7, on the question of bonding the city for $45,000 for a system of water-works.

It has just been discovered at Fort Plain, N. Y., that the village's contract with the Fort Plain Water Company is void, and has been for several years. Unless the company will sell to the village, a new system will be constructed.

Systems of water-works are contemplated at the following places: Shullsburg, Wis.; Walkerton, Ind.; Guttenberg, Ia.; Fayetteville, Ark.; Winchester, Ind.; Flandreau, S. D.; Dunkirk, Ind.; Portland, Ind.; Attica, O.; Rock Valley, Ia.; Medford, Ont.; Stadacona, Que.; Stillman Valley, Ill.

CONTRACTS TO BE LET.

Sealed proposals will be received until July 9, at Bellevue, Ia., for the construction of a system of water-works. Wm. G. Stuart, city clerk.

Bids are invited until July 6, at Jefferson, Ia., for furnishing the material and constructing a system of water-works. M. E. Hall, city clerk.

Sealed proposals will be received at Waukegan, Ill., until July 5, for the construction of a system of water-works. Henry Thacker, city clerk.

Sealed proposals are invited until July 5, at Wilber, Neb., for a $20,000 water-works plant. Address A. A. Richardson, consulting engineer, Lincoln, Neb.

Bids are invited until July 14, at Zanesville, O., for furnishing all materials and constructing a steel standpipe, 25 feet in diameter and 100 feet high. Trustees of water-works.

Sealed proposals will be received by the clerk of the board of trustees of the Toledo state hospital, at Toledo, O., until July 10, for the construction of a water tower. H. A. Tobey, secretary.

Sealed proposals will be received by the board of water-works until July 7, for the construction of a system of water-works at St. Bernard, O., which will comprise pumping machinery, stop valves, fire hydrants, cast iron, water pipe, stand pipe and foundation. Address H. J. Witte, president, Ludlow Grove P. O.

CONTRACTS AWARDED.

The contract for the Columbia City (Ind.) water-works was awarded to Grimes & Moran, of Elkhart, for $25,687.66.

The construction of the water-works system, at Morris, Ill., will be superintended by Voorhees & Witmer, of Buffalo, N. Y.

The U. S. Wind and Engine Company, of Batavia, Ill., was awarded the contract for constructing a system of water-works at Prairie City, Ia.

The contract for constructing a system of water-works at Lowville, N. Y., was awarded to E. G. Ferris and L. J. Richardson, of Watertown, N. Y. The awarding of the contract occasioned some surprise, owing to the fact that the bid of Ryan & Avery, of Watertown, was $166 lower than any other bid offered.

BRIDGES.

C. L. Stilson, Oroville, Cal., invites bids until July 5, for erecting two wooden bridges.

A movement is being made to build a bridge across the Wisconsin river at Lone Rock, Wis.

O. M. Harvey, Cathlamet, Wash., invites bids, until July 10, for constructing a draw bridge.

Agitation is kept up at Toledo, O., for the construction of a new bridge across the Maumee.

The commissioners of Allen county, O., have in contemplation the erection of a number of bridges.

Bids will be received at Jersey Shore, Pa., until July 3, for a new bridge at Allegheny and Railroad streets.

The contract for the new steel bridge over Grand river at Dimondale, Mich, has been awarded to the Wrought Iron Bridge Company, of Canton, O., at $3,300.

Bids for the superstructure of the high wagon bridge across the Mississippi at Red Wing, Minn., will be opened July 13.

A plan is being considered at Appleton, Wis., for building a street bridge across the ravine at an estimated cost of $10,000.

The question of constructing a new bridge in place of the old one over the Kaw river, at Kansas avenue, Topeka, Kan., is again being agitated.

The Wrought Iron Bridge Company, of Canton, O., was awarded the contract for building an iron bridge across Fishing river, near Excelsior Springs, Mo.

The State engineer has been authorized to advertise for bids for the construction of the Yampa river bridge at Denver, Col. The estimated cost of the bridge is $5,000.

Bids are invited by the department of works, in New York City, until July 10, for alterations to the arch conveying the Croton aqueduct across Nepperhan avenue in the city of Yonkers.

The Guernsey county commissioners will receive bids at Cambridge, O., until July 12, for the construction of an iron bridge over Wills Creek, with one span 160 feet in length and with a roadway of 14½ feet.

Sealed proposals will be received by the board of supervisors of Warren county, Mississippi, until July 3, for building an iron draw bridge across the Big Black river, at or near Hankinson's Ferry. J. D. Laughlin, clerk, Vicksburg, Miss.

A new steel cantilever bridge is to be built across the gorge at Niagara Falls, just below the cataract. It will be a combination of the arch and cantilever principles, with a span of 1,000 feet, and will carry trolley cars, railroad cars and foot passengers.

A contract has been effected between the county commissioners and Freeman E. Krech, W. B. Marr, Warren Potter, James U. Marr, James McDonald and F. M. Shook, business men of Aitken, Minn., who pledge themselves to build a wagon bridge across the Mississippi river within one year from date or less, and the commissioners agreeing on behalf of the county to accept it as soon as possible, after completion.

It is reported that the first steps toward building the North River bridge, at New York, will be the making of contracts between the bridge company and the various roads on the west side of the river. These contracts will be the basis for earnings and for the sale of the company's bonds, which will be for 50 years at five per cent. The bridge alone is expected to cost between $15,000,000 and $20,000,000. The soundings have been made and surveys completed.

City Engineer Porter, Niagara Falls, N. Y., has reported his investigations regarding the cost and details of a bridge across the hydraulic canal at Second street. It will be a two-truss bridge, with a driveway between the trusses, thirty-six feet wide and a side-walk five feet wide. The bridge is to bear a weight of ninety pounds to the square foot. The estimated maximum cost of the bridge, complete, is $8,000, and the estimated minimum cost is $7,000.

The new Columbus street bridge, at Cleveland, O., is considered a very unique structure. It will be two bridges in one, and is described as follows: Each bridge will consist of a span 134 feet long, and both bridges will meet in the middle of the river, the point of contact of the one being convex and that of the other concave. Each will be supported on a rim-bearing turntable operated by electric motors, and both will be operated by one motorman. It will be so arranged, however, that in moving the bridges the bridge with the concave edge can not be moved till after the one with the convex edge has swung and is out of the way. The piers on which the turntables are to rest will be close to the shore, on either side of the river, leaving a wide channel in mid-stream. The shore edges of the bridges, which will end in abutments well away from the docks, will not rest on the abutments, but will be locked into the masonry. The whole structure will have a twenty-foot roadway and a six-foot sidewalk on either side. There will be sixteen feet clear headway for teams. Each bridge will be a combination of pin and riveted truss, and will be made of soft and medium grades of steel. Between the piers on which the turntables will rest, there will be a clear passageway for vessels of 115 feet. Between the dock line and the south abutment of the bridge on shore, room will be left for three tracks of the New York, Pennsylvania and Ohio Railroad Company, and also for the dock space adjacent to Columbus street, which is at present of no use because inaccessible.

PUBLIC PARKS.

A city park is proposed at Van Buren, Ark.

A syndicate of Chicago and Aurora capitalists contemplate establishing a new park at Aurora, Ill.

The park commission at Des Moines, Ia., has bought another park, containing eighty acres. The cost of the land was $24,500.

The plans for the park at Farmington, Ia., land for which was donated by the late Ira Anderson, include a carriage-way, two artificial lakes, a grand stand for speaking and music and a fountain.

STREET RAILWAYS.

An electric road is to be built from Newburg to Orange Lake, N. Y.

An electric street car line is proposed between Brazil and Terre Haute, Ind.

An electric railway is proposed from Lynchburg to Bedford City, Va. Address C. S. Hutter, Lynchburg.

The Citizens' Street Railroad Company, Memphis, Tenn., has surveyed for an electric railroad to Binghamton.

An electric railway is contemplated in Brooksville, Ky. Y. Alexander, cashier of the Bracken county bank, is interested.

An electric railway is proposed from Staunton, Va., to Monterey. Address Secretary Chamber of Commerce, Staunton, Va.

An electric railroad is proposed to connect the Santa Fe and Velasco Terminal Railways. Address W. A. Rowan, Velasco, Tex.

A new electric railroad is proposed between Lancaster and Nicholasville, Ky., a distance of 22 miles. Address Fred Balcom.

MUNICIPAL BONDS.

S. V. Hull, Hamilton, O., invites bids until July 3, for the purchase of $60,000 sewer bonds.

R. B. Poage, Winton Place, O., invites bids until July 9, for the purchase of $1,500 of bonds.

J. N. Gamble, Westwood, O., invites bids until July 9, for the purchase of $2,690.80 bonds.

C. E. Lynch, Lima, O., invites bids until July 9, for the purchase of $30,000 of 6 per cent. bonds.

J. Rex, Tiffin, O., invites bids until July 17, for the purchase of $35,000 6 per cent. improvement bonds.

S. M. Serkland, St. James, Minn., nvitesi bids until July 6, for the purchase of $30,000 6 per cent bonds.

Charles Loeb, Charleston, W. Va., invites bids until July 9, for the purchase of $50,000 6 per cent. bonds.

B. F. Eason, city clerk of Wooster, O., will receive bids until July 6, for the purchase of $8,500, $2,850, $10,500 and $3,090 of street improvement and sewer bonds.

J. G. Overman, St. Bernard, O., invites bids until July 19, for the purchase of $5,886.84 6 per cent. street improvement bonds and for $2,753.68 of 6 per cent. bonds.

The corporation of Ashland, O., will sell on July 16, $20,500 worth of street improvement bonds at 6 per cent. interest. Principal and interest payable at First National Bank, Ashland, O. Interest payable annually. Denominations, $250 and $500. Bearing date July 2, 1894. See sealed proposals.

SEALED PROPOSALS.

SEWERS.

Sealed proposals will be received by the city council of the city of Mattoon, Illinois, until 7 o'clock P. M., the 24th day of July, 1894, for the construction of sewers in drainage district No. 1, as follows:

No. 1—Main line:
1,727 feet 24 inch pipe sewer.
730 feet 21 inch pipe sewer.
766 feet 18 inch pipe sewer.
766 feet 15 inch pipe sewer.
631 feet 12 inch pipe sewer.

Branches:
E street branch 350 feet 10 inch pipe sewer.
G street branch 370 feet 10 inch pipe sewer.
I street branch 370 feet 12 inch pipe sewer.
K street branch 370 feet 12 inch pipe sewer.
11 manholes, 9 lampholes.

No. 2:
3,200 feet 12 inch pipe sewer.
4 manholes, 4 lampholes and 13 inlets and connections.

Copies of the ordinance, specifications and bidding blank may be obtained at the office of the city engineer. Bids made otherwise than upon the blanks furnished will not be considered.

The proposals must be sealed and addressed to F. W. Becker, city clerk, and be endorsed with the name of contractor or firm of contractors making the tender, and be accompanied with a certified check to the amount of $500.00, made payable to the city of Mattoon, Illinois.

Bidders may bid upon either No. 1 or No. 2, or upon both No. 1 and No. 2, but each bid must be accompanied with a certified check of the amount named above. Work must be commenced within 30 days after signing the contract and finished by the 1st day of December, 1894.

The city council reserves the right to reject any or all bids. J. F. Scott, Mayor.

M. B. Fitch, City Engineer.

F. W. Becker, City Clerk.

SALE OF BONDS.

The corporation of Ashland, Ohio, will sell on July 16th, at 2 o'clock P. M., twenty thousand five hundred dollars ($20,500.00) of street improvement bonds at six (6) per cent. interest, the principal and interest payable at the First National Bank, Ashland, Ohio. Interest payable annually. Denominations of bonds $250 and $500. The bonds will bear date from July 2, 1894. C. G. Ducomb,

City Clerk, Ashland, O

ROAD TOOLS

Each of these machines

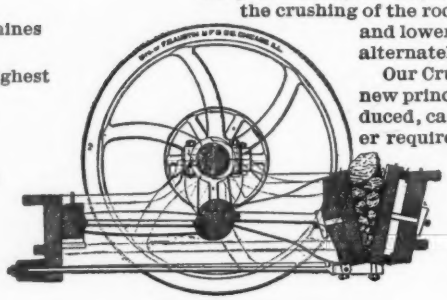
was awarded the highest

MEDAL

of merit in its class

at the

WORLD'S FAIR.

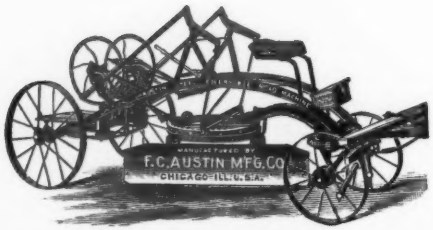


AUSTIN ROCK CRUSHER.

The jaws having a compound oscillating movement, the crushing of the rock is continuous, the upper and lower half of the jaws crushing alternately.

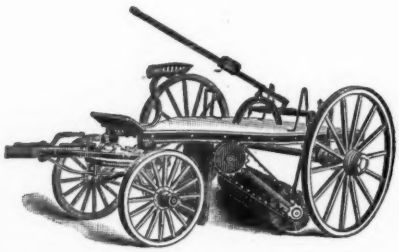
Our Crusher embodies an entirely new principle, whereby weight is reduced, capacity increased, less power required and life of Crusher prolonged. We claim (all things considered) to have the best Crusher made, and court comparison.

Capacity up to 250 tons per day.
No. 3—Capacity 10 to 15 tons per hour.
No. 4—Capacity 15 to 20 tons per hour.



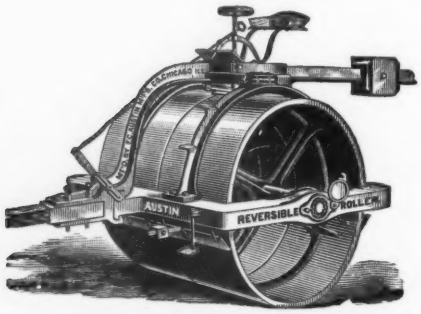
AUSTIN STEEL REVERSIBLE ROAD MACHINE.

The strongest, neatest and most complete Grader sold. Saves seventy-five per cent. in cost of work over old methods. Energetic agents wanted in unoccupied territory.



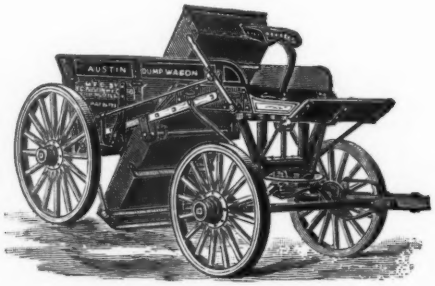
AUSTIN STEEL STREET SWEEPER.

Lightest running, strongest and most efficient. Two horses only. Sweeps 7½ ft. Cleans thoroughly any kind of pavement.



AUSTIN REVERSIBLE ROLLER.

Has anti-friction roller bearings. No weight on horses' necks. Is reversed or brake applied by driver without leaving his seat. Lightest draft and most easily handled—1½, 3½, 4, 5, 6 and 7 tons.



AUSTIN DUMP WAGON.

Quickly and easily dumped without stopping the horses. Has steel pan and steel-lined box. Holds 1½ to 2 yards. Used for hauling earth, brick, sand, stone, coal, street sweepings, etc.

FOR CATALOGUE AND PARTICULARS, ADDRESS

F. C. AUSTIN MFG. CO., Chicago, Ill.